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ON THE HABIT WITH CERTAIN CHALCIDOIDEA OF FEEDING AT PUNCTURE HOLES MADE BY THE OVIPOSITOR

By L. O. HOWARD

In his article on the importation of *Tetrastichus xanthomelænæ* in the Journal of Economic Entomology, Volume I, No. 5, 1908, pages 281-289, the writer described the observations of Paul Marchal on this European Tetrastichus in which he showed that in many cases the ovipositor is used as a pin to pierce the shell of the egg in order that the adult may suck its contents. He showed that many punctures were made in this way without oviposition and apparently for the purpose of feeding. Similar observations were made by Mr. W. F. Fiske when this same parasite was imported into this country.

Again in the Journal of Economic Entomology, Volume II, No. 4, August, 1909, page 278, Dr. H. T. Fernald mentions an undetermined parasite of the eggs of the asparagus beetle (*Crioceris asparagi*) and in a circular of the Massachusetts Agricultural Experiment Station (No. 23, published July, 1909) Doctor Fernald states that one of the observers of this insect at Concord, Mass., reports seeing the parasite occasionally attack the eggs with its mouth parts, consuming the contents of the eggs. He stated that he had not observed this himself and was of the opinion that the observation needed verifying. Mr. C. W. Prescott, of Concord, Mass., on May 23rd noticed that a number of the eggs of the asparagus beetle were empty and dead. He told Mr. J. B. S. Norton, of the Bureau of Plant Industry, who was there, about it, and together Mr. Prescott and Mr. Norton examined the eggs carefully. They saw the parasite thrust

its ovipositor into the eggs, and afterwards noticed it mouthing the aperture and apparently absorbing the contents of the eggs. This observation was reported to the Bureau of Entomology, and Mr. A. F. Burgess of the Bureau visited Mr. Prescott's place and verified the observations. In several instances he noticed that the parasites licked the wounds made by the ovipositor after it was withdrawn from the egg, but in other instances direct feeding upon the eggs appeared to be evident by their gradual collapse. The parasite in question was described by Mr. J. C. Crawford in the Proceedings of the Entomological Society of Washington, Volume XI, No. 3, October, 1909, as *Tetrastichus asparagi*, from specimens received from Doctor Fernald.

In the Comptes rendus hebdomadaires des Séances de l'Académie des Sciences de Paris, vol. CXLVIII, no 18, p. 1223–25, May 3, 1909, Dr. Paul Marchal gives some interesting observations on the oviposition of Aphelinus, under the following title: "La ponte des Aphelinus et l'intérêt individuel dans les actes liés à la conservation de l'espèce." His observations were made upon *Aphelinus mytilaspidis* in relation to *Aspidiotus ostreaformis*. The observations in brief are as follows:

"Before egg-laying the Hymenopterous insect places itself above the center of the scale which covers and completely hides each of the Coccidæ. Then it advances slowly towards the periphery of the scale with a light, balancing, sidewise movement of the body and palpitating with its antennæ. Arriving at the edge it turns brusquely towards the center, and on different occasions it begins again in other radial directions the same manœuvres without leaving the Coccid. The object of these singular preliminaries seems to be to explore the Aspidiotus in order to find out whether the conditions requisite for the laying exist, and perhaps also to choose in this Aspidiotus an appropriate spot for the egg which it is to insert. In July it happened that many of the scales covered only dry Aspidiotus which had been killed by the parasites of the preceding generation, and the Aphelinus were obliged to visit many before finding one which was in good condition for laying. In general they did not remain long upon the dried Aspidiotus, and after having explored them by some movements from the center to the periphery they abandoned them.

"When on the contrary the Aphelinus found living Aspidiotus, it explored for a rather long time, according to the method just indicated, and then inserted its ovipositor so as to completely pierce the scale. The ovipositor, at first only partly inserted, finally penetrated completely, so that the belly of the parasite came in contact with the

scale of the Coccid and the ovipositor remained thus inserted for some minutes. The Hymenopter then withdrew the ovipositor and applied its head to the puncture and licked the imperceptible moisture. It then again inserted its ovipositor, and again the puncture was licked.

"I have thus seen one of them pierce the same Aspidiotus eight times and each time bend its head to the wound to lick the liquid which issued. Without interruption, it pierced and licked alternately for about forty-five minutes up to the time when I stopped it. The number of punctures given by the Aphelinus to the same Aspidiotus is very variable. Frequently it does not exceed two or three, but it can also be much greater.

"It is very certain that each thrust of the ovipositor does not correspond to the deposition of an egg, for I have only once found wo eggs of the Aphelinus in one Aspidiotus upon which one of these ymenopters had worked in its accustomed manner for an hour. In ther cases it has been impossible not to discover the egg of the parasite, which is rather large and could not escape my attention. It is hen very probable that the Aphelinus pierces certain Aspidiotus only 'or nourishment. In any case many of the stings with the ovipositor re given exclusively for this reason."

Just as Marchal's observations upon the curious feeding habit of he Tetrastichus on the elm leaf-beetle eggs were soon followed in America by observations upon a congeneric insect attacking the asparagus beetle eggs, so in the case of the Aphelinus and its Diaspine ost Marchal's observations have been verified in America. At this late of writing the writer has before him a note made November 7, 1908, by Mr. J. G. Sanders, then of this Bureau. Mr. Sanders's note reads as follows:

"The oviposition of *Aphelinus fuscipennis* on *Aspidiotus rapax*.

"On opening a package of *Aspidiotus rapax* from Catalina Island, California, several parasites, *Aphelinus fuscipennis*, were noticed upon the twigs. One female was observed upon the summit of a female scale of *Aspidiotus rapax* critically examining the surface of the scale with innumerable sweeps of the antennæ from the margin to the apex of the scale. After a moment's observation the ovipositor was thrust into the scale near the apex, and constant working of the abdomen was continued for eight minutes, when the ovipositor was withdrawn and the Aphelinus turned about *and apparently sealed the wound in the scale with her mandibles.*"

An attempt has been made to watch the oviposition of other scale insect parasites in the Department greenhouses since the arrival of

Doctor Marchal's last paper, but nothing comparable to his observations has been noticed as yet. We have, however, now four independent observations upon four different species of parasites and hosts, and it seems more than probable, now that attention has been called to this matter, that this interesting and apparently (to the species concerned) important habit will be found to be quite widespread.

I close this note with a transcription of Marchal's closing paragraph in his last paper:

"Ces exemples, que les observations ultérieures ne pourront manquer de multiplier, montrent que l'intérêt individuel peut se manifester assez fréquemment par des habitudes normales dans l'accomplissement des actes qui accompagnent la ponte et qui ont pour but d'assurer la conservation de l'espèce chez les Insectes. Il y a là un facteur jusqu'ici négligé et dont il convient de tenir compte dans l'étude de l'évolution et de la spécialisation souvent si étroite des instincts liés à la reproduction qui s'observent chez les Insectes et, en particulier, chez les Hyménoptères."

LOCUST DESTRUCTION IN SOUTH AFRICA

By C. W. Howard, *Chief of Entomological Section, Department of Agriculture, Moçambique*

Probably nowhere in the world have locusts been so destructive and exercised such a baneful influence on agricultural pursuits as in South Africa, and nowhere else has so unique a method for combating them or so perfect an organization for local extermination been developed. Although reports of the work have been frequently noticed in American Entomological publications, I know from personal correspondence that very few of the American workers are thoroughly familar with this South African work. For this reason a brief resumé may be of interest. It will deal mostly with conditions in the Transvaal as it was in that Colony that the author had the privilege of conducting two large locust campaigns.

Locusts have been known in South Africa since the earliest records. Immense swarms in the earliest days of settlement are said to have swept down into Cape Colony from the North and North West, destroying everything before them.

I myself have seen swarms with a frontage of 15 or 20 miles and at least 60 or 70 miles long, taking several days to pass a given point and filling the air so thick that the glint of the sun on their wings made one easily fancy he was in a snowstorm. Traveling through such a swarm is not pleasant and many horses will not face it. More

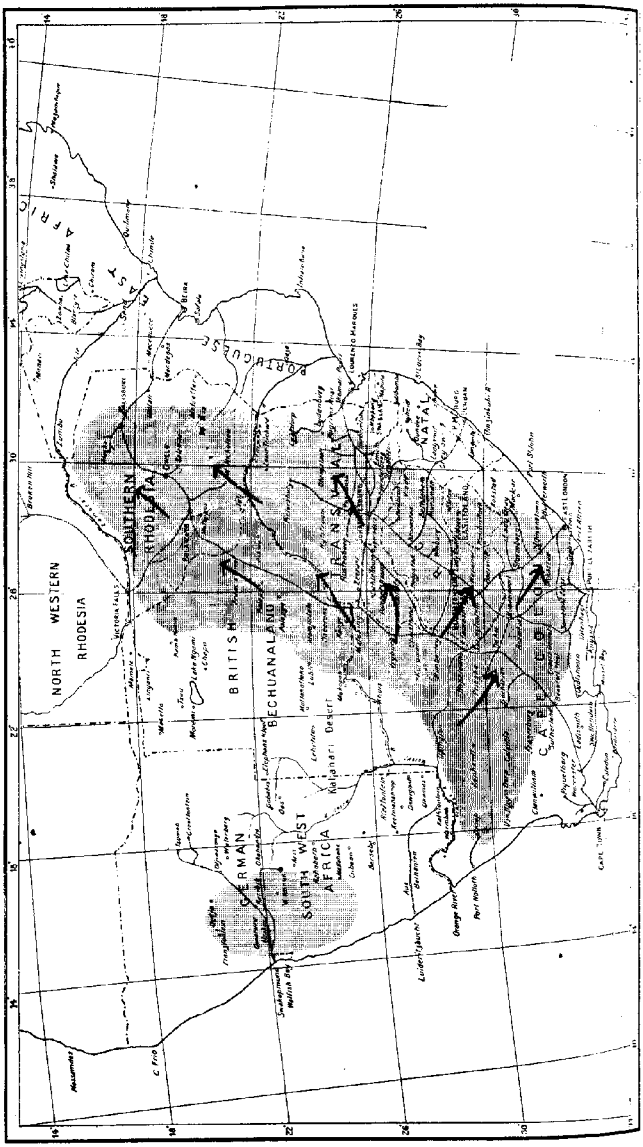
over trains were often delayed by the greasy crushed forms on the tracks. A swarm such as this will do a vast amount of damage. Scarcely a green thing is left behind, even the washing hung to dry on the line may be partly devoured and the ground is covered with a thick carpet of the fæces. Large trees are completely broken down by the weight of the sleeping locusts at night; the veldt is stripped bare of the green grass in the dry season and every winter crop of grain, etc., is cut down. When there are dozens of such swarms in a country the size of the Transvaal it can easily be imagined what the results are to the farming population. During the invasion of the winter of 1906 we endeavoured to secure statistics of the loss occasioned, and we found that at least £1,000,000 of crops, including damage to the veldt, had disappeared into the stomachs of these locusts.

The flying locusts come in the dry season when few crops are growing and those usually small in plots which can be irrigated and which can be protected, at least partially, from the ravages of the flying locusts. But with the first rains come the hoppers, the progeny of invading swarms of flyers. The hoppers have been aptly termed voetgangers, by the Dutch population, voetganger being the term for infantry. When a district is full of hoppers, not in swarms of feet or yards in extent but often actually miles in extent, marching like an army so thick as to turn the veldt brown, the farmers may well give up in despair. Nothing will turn them from their course and every green thing disappears before them.

During the season of 1906–'07, referred to above, when locusts oviposited in enormous numbers over the whole Transvaal, the statistics, also referred to above, showed that at least £10,000,000 worth of crops were preserved through the actions of the Government, which would have otherwise been destroyed and the population both black and white reduced nearly to starvation. This work of destruction was done by the Government at a cost of about £12,000, an infinitesimal sum compared with the value of the crops saved. So thoroughly was the work done that scarcely a swarm of voetgangers was able to escape destruction and reach maturity.

To correctly understand the locust problem of South Africa, however, it must be remembered that we have two species of locusts, distinct in their habits and distribution. This is a fact ignored by many European writers on the subject and has caused much confusion. Because locusts also occur in Egypt, Algeria and Central and East Africa many have tried to prove that the Sahara desert was the center from which locusts spread out North, East and South over the

Plate 17



Approximate area which may be covered by Flying Brown Locusts during the winter invasion

whole continent; whatever may be the facts concerning North and East African locusts those of South Africa, so far as we have been able to ascertain have no connection therewith.

I shall avoid the points still open to discussion and state briefly the main facts about the migrations and life history of these two locusts.

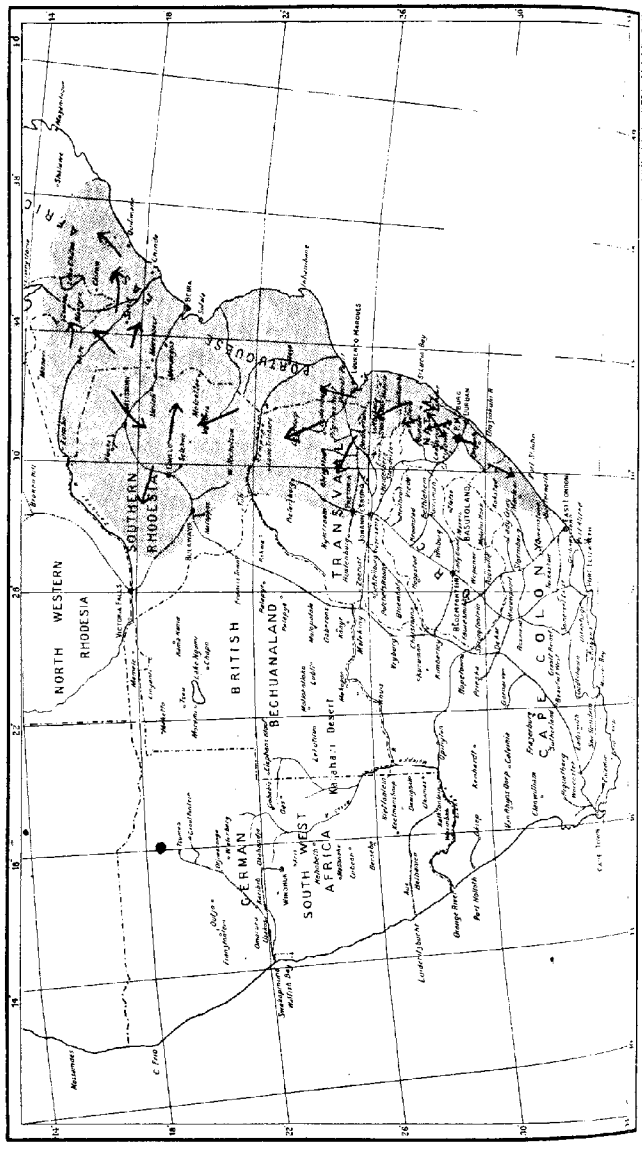
The most destructive and the most difficult to combat is the Brown Locust (*Pachytylus sulcicollis*). It is a small locust of quite a uniform brown or dark straw color. Its permanent summer quarter January to March or until July) seems to be somewhere in the Kalahari desert and German South West Africa. From here they begin to spread out in March, but sometimes not until July, the winged swarms eventually covering an area which may include, Central and Eastern Cape Colony, Orange Free State, Basutoland and most of Southern Rhodesia. Apparently they seldom cross to the North of the Zambesi River, and only at the height of the cycle will they cover the entire area mentioned above. So far as we can ascertain their flight is affected very little by winds, although certain seasons, for some reason, the bulk of the swarms turn to the south east from the Kalahari and during other seasons to the north east.

By about the first of July these winged swarms begin to oviposit. Each female deposits two or three pods of eggs of about 40 eggs each, and then perishes. Males may survive one or two months longer. The eggs lie in the ground until the first rains, which usually begin about the first of October. In two weeks after the rains the first hoppers appear, providing the atmosphere has been warm enough. Many variations as to time of hatching occur, owing to variations in the time of the beginning of rains and owing to the intensity of the first rains or the lack of proper temperature. I have seen eggs hatching only in the following February and March and eggs deposited in the areas of Cape Colony where rain only occurs once in 6 or 7 years, will remain dormant several years and still hatch. I have kept eggs myself two years; they hatching at the end of that period when they were subjected to proper conditions, and I believe that the Cape Entomologist has secured hatchings after a lapse of five years.

From 6 to 8 weeks are necessary for the growth of the nymphs, at the end of which time they obtain their wings and immediately fly toward the Kalahari. From the Transvaal they follow almost a beeline to the south west and this is true of Rhodesia, while from the Orange Free State they go westward.

The voetgangers of the Brown Locust remain from the very first in very compact swarms, sleeping in masses in grass and scrub during the night and moving in massed columns during the day. Swarms

Plate 18


NORTH WESTERN RHODESIA
SOUTHERN RHODESIA
BECHUANALAND
BRITISH
TRANSVAAL
BASUTOLAND
COLONY
CAPE
GERMAN SOUTH WEST AFRICA
PORTUGUESE
Kalahari Desert

hatched in close proximity gradually come together until miles of veldt will be covered with a mass of hoppers feeding and moving along as if under the command of a captain. Such swarms quite easily cross a river as large as the Vaal, by swimming and by forming a bridge of their massed bodies. This habit of massing together makes their destruction more easy.

The second locust, which has been given various names, such as Red-winged locust and Red locust (*Cyrtocanthacris septemfasciata*, long known as *Acridium purpuriferum*), is not so destructive as the Brown Locust. It does not cover so wide an area nor does it occur in such large swarms. The fact, however, that it occurs, not on the high interior plateau, but along the coast in very unhealthy and uninhabited parts and also the fact that the hoppers do not form such compact swarms as do those of the Brown locust, all tend to make the carrying out of measures directed against it more difficult.

The red locust is much larger than the brown and at the breeding season assumes a bright wine color on the hind wings, giving it its name. At the time of first reaching maturity the whole body also takes on a dark reddish brown tinge.

Two areas seem to be the centres of distribution for this locust. Small swarms may sometimes winter in almost any sheltered valley in the low veldt of South Rhodesia, Eastern Transvaal, or Moçambique. To the south, Natal and Zululand seem to be the favored area. To the northward the area about the Zambesi river especially south of that river and in the extreme Eastern part of South Rhodesia are always winter quarters for red locusts. From winter quarters in Natal and Zululand beginning in October, they spread out over Natal, Zululand, Swaziland, eastern Transvaal, and southern Moçambique, while Southward they may infest the coastal area of eastern Cape Colony. In the North they spread out from the Zambesi River over the Zambesia district to the northward of Quelimane; over the southern extremity of Nyassaland and over most of South Rhodesia. Red locusts are present in the northern parts of the Province of Moçambique, but as there are no white inhabitants there and the natives are not yet in subjection, very little information can be secured. The relation between these northern and southern centres of emigration is not yet known. Probably in a year when the locust cycle is at its height, swarms would migrate from Zululand all along the coast toward the Zambesi; and reports seem to indicate that swarms have passed over the Eastern Transvaal into Rhodesia. As I state above the Red locust is a coastal locust and is confined usually to the wet, humid and hot coastal areas and low veldt, but in years of unusual abundance swarms

may oviposit on the high and middle veldt of the Transvaal and southern Rhodesia covering the eastern two thirds of these colonies, so that we may then have a double infestation of locusts making the problem a more serious one.

By the first of December the Red Locusts begin to oviposit, each egg pod containing about 95 eggs. The females die and the males live on for some time more. They usually select very choice spots for oviposition, such as newly planted sugar plantations. On the Zambesi we have seen at least twenty tons of eggs dug from an area of not more than 100 acres. The eggs of this locust are not so dependent on rains as are those of the brown locust. Indeed they are usually deposited long after the rains have begun, unless it be a year of unusual drought, so that in two to three weeks after oviposition the young hoppers begin to hatch out. That is in the South the hoppers begin to appear about January first, while in the North they may be found by the middle of December.

In about two months the hoppers have reached maturity, and come together into more compact swarms than before. When they have assumed their wings they make for winter quarters, although, as we have pointed out, summer and winter areas and migrations are not so well marked out as is the case with the brown locust.

In the Transvaal and South Rhodesia it usually happened during bad seasons that as soon as the campaign against brown locusts had ceased another had to be begun against the red locust, so that the whole year, from the end of the dry season until the end of the wet season, was spent upon this one problem.

Before going farther it may be well to describe the method employed in South Africa in destroying locusts, as it is one peculiar to South Africa and so far as I know has not yet been employed elsewhere. Indeed some Entomologists in other continents, refuse to acknowledge its efficacy in spite of the lengthy reports annually issued by the various Agricultural Departments of South Africa.

It was early recognized that it was useless to attempt to destroy winged locusts at the migrating season, although every method which could be devised for their destruction was encouraged; even to urging the natives to use them more commonly as an article of food. The most that could be done was to call out all natives and white people on the approach of a swarm of locusts and by the use of smoke or beating of tins drive them off of a crop and compel them to settle elsewhere. This, however, is not an easy matter. A locust which has flown a number of miles is usually hungry and a little smoke or a little noise in a nice green field of maize or forage will not prevent his

breaking his fast. Consequently all the efforts at actual destruction were centered on the voetgangers. At first the various methods suggested in the locust reports of the United States of America, Egypt, Cyprus, and Argentine, were tried, from the digging of eggs to the use of rollers, trenches or screens and pits, to that of the famous locust fungus. All were found ineffective, owing to conditions existing in South Africa. The population is very sparse, labor is scarce and expensive and transportation and materials are very costly. Moreover these methods were not thorough and could not be carried out over wide areas except at great expense to the Government and the people were not yet broad minded enough to take up the work on their own initiative. The old Boer was indolent enough to accept a locust plague as a punishment for his sins and resorted to prayers and days of fasting, like our half-civilized ancestors of the middle ages, in the hopes of seeing a miracle wipe them out.

It remained for Natal to devise a method of voetganger destruction which is remarkable for its simplicity, cheapness and ease of application. The history of this discovery is interesting.

The sugar planters in Natal found the locusts very troublesome about 1894. They tried every method of destruction and amongst others the pit and screen system. The hoppers were driven into the trenches which were about two feet deep and in the bottom of which was placed four to six inches of treacle, a waste product from the sugar mills. The treacle held and smothered the hoppers. But it was soon noticed that when the trenches were filled with earth some treacle oozed out and the survivors hung about and ate the treacle and that fresh swarms seemed to be attracted to the treacle and ate it. They then tried poisoning the treacle and found arsenic the best poison. The next step was the use of a bait made of boiled sweet potatoes, molasses and arsenic, but this soon gave place to poisoned molasses sprinkled about on the grass. The credit for the discovery so far belongs to Mr. Gilbert Wilkinson a sugar planter of Natal. This method was followed for some time with considerable success. Later, I believe, at the suggestion of Mr. Lounsbury, the treacle and poison were made into a thin solution and sprayed on the grass and vegetation. This sweetened arsenical-spray is what has revolutionized the whole work of locust destruction in South Africa, because of its simplicity in mixing and applying and its complete effectiveness. The formulæ for its use vary with the size of the hoppers to be killed and the urgency of killing them. The usual strength employed is 1 lb. of arsenite of soda and 2 lbs. of crude sugar or molasses to 16 gallons of water but in special cases it may be made as strong as 1 lb.

of arsenite of soda in 8 gallons of water. Its effectiveness lies in the sugar or molasses of which locusts are very fond and to which they are attracted long distances by the odor. It is therefore best to use as crude and strong smelling a substance for sweetening as can be procured. At first white arsenic was employed, as a poison, which had to first be boiled with caustic soda to produce a soluble compound. The late Mr. Simpson improved this by introducing the use of arsenite of soda which is soluble in cold water. The latest improvement is the production of a concentrated stock solution of arsenic and sugar. Such a compound has been made, at the writer's suggestion, by the Atlas Preservative Co., of England and is known as *Atlas Locusticide*. It is put up in 1 gallon and 5 gallon tins and only needs to be mixed with the proper quantity of water before using. Locusticide has helped very much to push the work in the coastal regions such as Moçambique where transport is difficult and costly and where incompetent persons often have to prepare and handle the spray. In Cape Colony they prefer to prepare their own concentrated solution from arsenite of soda and molasses; but in other parts the cost of tins and the skilled labor necessary make such a method impossible.

The method of applying the spray is to locate a swarm of hoppers and note the direction in which they are moving. Then late in the afternoon or early in the morning spray a strip of grass varying in width from 20 feet to wider, depending on the size of the swarm, clear across the front. If it is a small swarm spray a ring completely around them. During the night the hoppers bunch up together on the grass or bush to sleep, and in the morning as soon as the sun has dried off the dew they begin to eat and move outward. Consequently if a choice bit of grass has been sprayed, this is what they will attack first. They will die in from one or two to 24 hours, depending on the strength of the solution used. So fond are they of the sugar that if not enough sprayed grass is left for all the hoppers the last comers will devour the first which have died or are dying and so one dose of poison may often kill 3 or 4 hoppers.

The writer once visited a small town in the north Transvaal which was being overwhelmed with locusts. The locust officer had just sprayed a strip of grass about 10 or 15 yards wide clear across one side of the town lands or commonage to cut off an approaching swarm of hoppers. This swarm was at least 5 miles across the front. On they came till they struck the sprayed grass where they staid awhile and fed. The spray had purposely been made weak to avoid the danger of poisoning cattle and the hoppers had taken some time to die. But when we arrived every fence corner and every corner of a house

Voetgangers killed by applications of sweetened arsenic.

and even the streets themselves were covered with dead hoppers and so overpowering was the stench that wagons had to be put on and load after load of dead hoppers was taken away to be buried.

When the late Mr. Simpson came to the Transvaal as Entomologist, it was not long before he saw that it was impossible for farming to advance until the locust problem was solved. He, therefore, began a study of the question at once. His first move was to study carefully the migrations of the swarms of flying locusts. To do this post cards were prepared. On one side was the address and franking stamp, on the other properly ruled spaces for the required information. These cards were distributed to every farmer, police, post master, railway station master, agricultural society and in fact every person who would accept them. As soon as they saw locusts they marked on the card whether they were flyers or hoppers, direction of flight or movement, egg laying, etc. As each card came in the information was recorded with pins and flags on a large map of the Transvaal and at the end of each month copied in colors on a small map. If the cards reported swarms of flying locusts which we thought would pass into other inhabited areas, telegrams of warning were at once sent out, so that farmers could be prepared to drive them from their crops. After a few months of such records had been examined, it could be easily forecasted in what parts of the Transvaal the locusts would oviposit and consequently where work of destruction would have to be carried on. This system was taken from a suggestion of Knuckel d'Hercules in his work on locusts in Algeria, and was of very great value. After two or three years of studying the migrations of locusts in this way, their movements could almost be forecasted before they approached.

The next step was to get the hoppers destroyed as soon as they appeared. At first the Transvaal farmers were afraid of the arsenic, so the Cyprus locust screens were used. After one season, however, they were abandoned as too clumsy and ineffective. In the meantime experiments and demonstrations had been carried on with the Natal spray and this method was adopted entirely. The arsenite of soda and sugar were given free to the farmers while the spray pumps (Myer's Success Bucket Pumps) were loaned free of charge. Where it was impossible to persuade a farmer to use the poison he was allowed to use a strong solution of soap and water to spray upon the hoppers. This was not very effective and took too much time to prepare, so as a rule he soon came around to the poison method.

The phenomenal success which followed the work depended, however, on the organization. The year's campaign was always preceded

by the Entomologist making a tour through the infested country, during which illustrated lectures were given, to interest the farmers in the work. Some time before the hoppers were due to hatch out, the poison and pumps had been distributed to centres convenient for distribution to farmers. Then locust officers were appointed. The Transvaal is divided into several districts over each one of which in the affected area was placed a locust officer, directly responsible to the Entomologist as Chief Locust officer. Large districts were subdivided and officers placed over each division directly responsible to the district officers. Then under these sub-district officers were men whose duty it was to go to native locations and government lands to see that all hoppers were destroyed on them, and others to go among the farmers, giving demonstrations and persuading each man to kill the locusts on his own farm. Only men who thoroughly understood the farmers and could use tact and discretion in dealing with them were chosen as locust officers. The locust staff often included as many as 160 men. This thorough system of organization meant that every man was at his post doing his duty carefully and promptly. The Entomologist was always at headquarters and by telegraph and telephone directed the whole campaign. The work was executed quickly and with no waste of money.

It, of course, took several seasons before all the farmers fell into line, but now there is scarcely a farmer in the Transvaal who will not swear by the locust killers.

From a study of the Transvaal locust reports Mr. Simpson soon saw that the Transvaal alone could not solve the locust problem. In spite of her good work, each year new swarms invaded the colony from outside and necessitated its repetition. He accordingly placed the matter before the High Commissioner of South Africa, who called a conference in Pretoria in August, 1906, to discuss the question. This conference resulted in the establishment at Pretoria of the Central South African Locust Bureau. This was largely Mr. Simpson's idea, but almost before its organization was begun Mr. Simpson died and its management was left to his successor. The Bureau was under the direction of the Transvaal Entomologist but was supported by funds from all the Colonies and territories in South Africa including the Province of Moçambique and German South West Africa. Its work was the collection and tabulation of information regarding locusts from the whole of South Africa. The Cape Colony had already introduced a system somewhat similar to that of the Transvaal for collecting locust reports and the other colonies and territories fell into line. These reports all went to Pretoria and were there tabulated

and a monthly record map based on these reports sent to each subscribing colony. Colonies were also warned by wire of approaching swarms of flying locusts and urgency reports issued on request.

Although the work of the Bureau was supposed to be only the collection of data, it was really much broader. In May, 1907, a conference of all the Ministers of Agriculture of the various colonies was called at Pretoria by the Transvaal Minister of Agriculture in conjunction with the annual meeting of the committee of control of the Bureau. At this meeting the Bureau was able to put forward facts of such importance that each colony pledged itself to initiate locust destruction work. That was the beginning and subsequently the work has gone on well, even the native territories undertaking locust destruction. Since then the Bureau has kept up popular interest by its annual reports dealing with the work of each colony by suggesting where improvements could be made and by the issuing of information for newspapers, etc.

In dealing with the locust question we should not forget the help received from natural allies. Locust fungus was found absolutely useless, and the work of Mr. Pole-Evans, Transvaal Plant Pathologist on the fungus, has, I think, settled the question of its use in South Africa for ever. Early in the work, many birds and small mammals were found to destroy great numbers of flyers and hoppers, and a law was passed protecting several of the more important birds. These allies could, however, only be of small assistance in combating such a scourge and although they were protected very little reliance was placed on their work.

Thus during the last three years there has been active coöperation in locust destruction throughout the whole of South Africa. The results of this coöperation soon showed themselves. After the first year Brown locusts in the Orange Free State, Transvaal and Rhodesia were very materially lessened, and the next year were almost lacking in those colonies, while the past season there were none. This past year brown locusts flew down from the Kalahari and German South West Africa into Central Cape Colony and oviposited there, but that is the only part of South Africa which has been infested. The Red locusts are also disappearing. Their numbers in Natal are lessening each year, while this season there are practically none in the Eastern Transvaal and Southern Moçambique. In southern Rhodesia and northern Moçambique they are still quite numerous, but the work there is being extended each year farther into the areas of egg laying with the result that they are slowly decreasing in numbers. In the district about the lower Zambesi river two years ago immense losses

were suffered from the destruction of sugar cane and cocoanuts by locusts. Last year work was begun in that area which resulted in the saving of about £250,000 worth of crops and as a further result this year locusts have invaded only a very small portion of the area.

Taking the locust problem as a whole there is, therefore, only one territory remaining over which there is not absolute control, i. e., Parts of German South West Africa. The German Government is doing its utmost to control the pest within its boundaries but when we remember the character of the country, with its vast extent of almost desert land, with no white population and no water, we can understand the impossibility of the task. We will probably have swarms of brown locusts invading the other parts of South Africa from that region from time to time. Beyond this, however, there is no reason why South Africa should have a recurrence of such a scourge as in the past, provided she is watchful and meets each small invasion with prompt action. Now that there is to be one government over all of British South Africa, the administration of such matters as locust destruction can be from a central office where the work can be more successfully directed than heretofore.

The locust work in South Africa has had a more far reaching effect, in the Transvaal at least, than the mere saving of the crops in imminent danger. It has succeeded more thoroughly and more quickly than years of teaching and publishing of reports could have done, in converting a conservative backward people to the value of new scientific methods in combating pests of all sorts. The farmer who was formerly inclined to laugh at the Entomologist as a "bug catcher" now listens to him and accepts his advice.

NURSERY INSPECTION IN MASSACHUSETTS

By H. T. FERNALD, *Amherst, Mass.*

In some respects the work of the nursery inspector in Massachusetts would seem to differ from that in most states. Of the one hundred and thirty odd nurseries requiring inspection, only two are at present growing any fruit stock, nearly all devoting themselves entirely to ornamentals. Large sales of fruit trees are made, of course, but the only evidence of this which the inspectors find during their fall inspections are small blocks of "left overs" from the spring purchases. Here, however, the San José Scale is frequently very abundant, sustaining the now well recognized fact that the inspectors in other states as well as in Massachusetts are not always infallible.

Most of the nurseries in the state are small, the average size perhaps

being ten or fifteen acres, while the largest ones are of less than two hundred acres. It is probable that almost all of the interstate shipping is done by twenty-five places, and it is remarkable how much of the stock sent out is purchased, often from the very states to which it goes.

Every nursery is actively at work shipping, by the first of October each year, and in order to complete the inspections in time to prevent holding up business, these must be begun by the tenth of July. The first places visited each year are those selling strawberries and hardy roses only, as here sales are practically continuous throughout the summer, and as by law all certificates expire July 1, these require the first attention. By the time these have been examined, work must be at once begun on the larger nurseries, which are actively shipping evergreens by the end of this month.

As to methods of inspection, there is little to be said. Fruit stock, Cornus, Viburnum, ornamental Prunus and Pyrus and other plants liable to infestation are examined individually under a lens, and with Cornus in particular, this means many weary hours during which the lowest parts of the body are the head, knees and tips of the toes. All such plants are examined separately and this is also the case with all kinds, at first. If after a prolonged search, however, no scale is found on them, the inspector considers himself at liberty to skip plants, examining every third or fourth, and finally if no evidence of trouble is found he may cross the rows in a block, examining each row as he crosses backward and forward until the block has been crossed several times at different points. From this sort of inspection nothing is considered exempt, though perhaps Berberis, Hydrangia and conifers are least thoroughly examined.

While such methods as these hold good in general, when the Gypsy moth is near the nursery, nothing can claim exemption and every plant in dangerous or even doubtful blocks is thoroughly examined. If the Gypsy moth is found, further inspection ceases until the fifteenth of September, as until that time a nursery might become infested from outside. After this date, inspection is resumed for such places and when nothing more can be found, a certificate is given, and as this expires before the next migration period for this insect, the result should mean as great freedom from it as inspection can make possible. In some cases where shipments before this date are imperative, an inspector personally goes over each plant dug, while it is at the packing shed, and if satisfactory, issues a certificate covering that shipment.

During most of the inspection period the Brown-tail moth is not

easily discovered, being either in the egg stage or in the form of very small larvæ. As it would be impossible to inspect the nurseries after the winter tents have been formed without practically preventing a large part of the business, it was decided in 1905 that inspections could not cover the Brown-tail moth, and notice to that effect was issued, while the nurserymen themselves were warned to watch for and remove any tents present on stock, unless they were prepared to lose their interstate trade.

The work as regards the Gypsy and Brown-tail moths then, is one in which this state differs from others. Other insects are watched for, of course, and occasionally found, but have thus far been of little importance as compared with those already considered. Fungus and other diseases occasionally appear, but as a rule the Gypsy moth, Brown-tail moth and San José Scale are the insects making most of the trouble.

Under the law of 1909 all nursery stock brought into Massachusetts must bear on each package, box, bundle, bale, car or other parcel, a tag issued by the Massachusetts Nursery Inspector. This has for the first time made it possible to gain some idea of the business done by other states in Massachusetts, and the result has been something of a surprise. A tag may mean a shipment of from one plant to an entire carload, but it is not likely that there are many single plants sent in this way, and as for the shipments of the fall of 1909 and spring of 1910, over thirteen thousand tags were issued, some conception of the value of Massachusetts business can be obtained.

Until the winter of 1908–09 it was impossible to get any definite information as to the amount of stock imported from abroad. During that winter, through the kind offices of Dr. L. O. Howard, some information was obtained from the Custom Houses, and during the past year it has been possible to gather data on this subject which appear to be practically complete. Thus far during the shipping season of 1909–10, three hundred and one consignments from foreign countries for points in Massachusetts have been received, most of this coming from Holland, followed by Germany, France, Belgium, England, Japan and Scotland, named in about the order of the amount of shipments. As much of this stock as possible has been inspected at its destination, but nothing has been found thus far on the European stock, except that on one lot of *Pyrus floribunda* from Holland, consisting of fifty plants, forty-five were badly injured by Crown Gall, including the worst examples ever seen by the writer. With the Japanese stock, however, it was different. A number of egg cases of the Chinese Mantis, *Tenodera sinensis* and also of another species

were present, and if these insects could survive, would be a welcome addition to the fauna of this state. Besides these, the bag of a small bag worm was found on the Umbrella Pine; a cocoon of what appears to be a Lasiocampid; an abundance of *Aulacaspis pentagona* on flowering cherry, and large numbers of *Pulvinaria camelicola* on *Euonymus alata* were found, and these on comparatively small shipments. From this, it would seem important to closely examine all stock reaching this country from the Orient. Europe has already contributed a sufficient number of insect pests, but the possibilities of the East in this regard have as yet been given little consideration, and they may prove to be serious.

THE INSECTICIDE ACT OF 1910

At the Chicago meeting of the Association of Economic Entomologists, December 27, 1907,[1] the Standing Committee on Insecticids reported as follows:

"The committee believes that it should ascertain whether it is possible to secure an interpretation of the national pure food and drug law so that it will include insecticides and fungicides, and if this is found impossible that the committee draw up and report to the next meeting of this Association a suggested law which will aid in securing uniformity of legislation in the various states as regards the compulsory analysis and labeling of insecticides and fungicides.

"Voted that the report be adopted and the committee continued."

The committee corresponded with the Bureau of Chemistry of the Department of Agriculture and found that it was impossible to so construe the Pure Food and Drug Act. The present bill was therefore drawn along the same lines as the Pure Food and Drug Act and was introduced in the Sixtieth Congress by Hon. Frank O. Lowden as H. R. 21318 and in the Senate by Senator Nelson for Senator Kittredge as H. 6515. The bill was referred to the Committee on Interstate and Foreign Commerce in the House, but it was not possible for that committee to consider it during the short session. In the Senate the bill was referred to the Committee on Agriculture and Forestry and was reported on February 1, 1909, by Mr. Burnham for the Committee. (Senate Report 895.)

It was found impossible to bring the measure to a vote in the Senate, though no opposition was encountered. The bill was again introduced in the original form in the present (Sixty-first) Congress

[1] See Journal of Economic Entomology, 1: 10.

by Hon. Frank O. Lowden of Illinois (H. R. 3658, 20989) and referred to the Committee on Interstate and Foreign Commerce.

The bill was introduced in the Senate by Senator Burton of Ohio (S. 6131). On March 8 a public hearing was given by the Committee on Interstate and Foreign Commerce of the House of Representatives to members of the Executive Committee named below assisted by Dr. J. B. Smith of New Jersey, Prof. E. L. Worsham of Georgia, Prof. T. B. Symons of Maryland, J. H. Hale of Glastonbury, Conn., and Mr. E. W. Catchpole of North Rose, N. Y., and a hearing was also given by the Senate Committee on Agriculture and Forestry. The bill was reported in the Senate on March 23 and passed the Senate April 4. The Senate bill was modified slightly to correspond with the House bill which was reported by the House Committee on April 12, passed the House in the amended form on April 18, which amendments were at once concurred in by the Senate, and the bill was approved by the President April 26. The committee highly appreciates the personal interest which both Mr. Lowden and Senator Burton evinced in securing the passage of the act and is under obligations to Chairman Mann and Senator Dolliver for the courtesy of hearings before their respective committees.

Upon the introduction of the bill in 1908, the Committee on Insecticides of the Association of Economic Entomologists consulted several of the leading manufacturers and found them favorable to such national legislation, but that they felt the entomologists, agricultural chemists and manufacturers should get together and confer over several minor changes in the bill which they desired. The committee therefore called a conference of all the manufacturers and leading entomologists and agricultural chemists, which was held at the American Institute, New York City, June 18, 1908. The meeting was a representative one of the three interests named. The bill in its original form was then taken up and carefully discussed, section by section, and amendments were made placing it in the form in which the bill was reported by the Senate Committee of the Sixtieth Congress, and the bill was finally adopted in that form. The bringing of these amendments before the proper authorities, and the proper presentation of the entire bill to those interested was left to a committee consisting of Prof. E. D. Sanderson, Entomologist N. H. Agricultural Experiment Station, Durham, N. H.; Prof. H. E. Summers, Iowa State Entomologist, Ames, Iowa; Dr. J. P. Street, Chemist Connecticut Agricultural Experiment Station, New Haven, Conn.; R. G. Harris, Sales Manager of the Vreeland Chemical Co., New York; and H. F. Baker, President of the Thomsen Chemical Co.

Baltimore, Md., with the understanding that if any material amendments were to be made that the conference be again called together for their discussion. This committee met and organized as an "Executive Committee" and proceeded to arouse public interest in the measure and to do what was possible toward the passage of the bill before Congress.

An Advisory Board, consisting of one member from each state, was appointed to aid in securing support for the measure in each state and to these gentlemen the committee is greatly indebted for the public-spirited interest.

Certain changes in the standard of lead arsenate having been desired by certain manufacturers, a meeting of the manufacturers of arsenate of lead was called at the Belmont Hotel, New York City, December 8, 1908, and after full discussion the committee was instructed to secure an amendment to that portion of Section 7 referring to the standard for arsenate of lead so that it should read as in the bill now law.

The bill having been reintroduced in the Sixty-first Congress another conference of the manufacturers was called by the Executive Committee to ascertain if any further amendments were desired, which met at the Hotel Woodstock, New York City, November 18, 1909. At this meeting there were thirteen firms represented, which firms produce fully 80 per cent. of the insecticides of this country and the larger part of the manufactured fungicides. It was voted to recommend that the bill be amended so that the penalties prescribed in Section 2 be the same in Section 1, with this amendment the manufacturers present heartily endorsed the bill as amended and pledged their support and coöperation toward its enactment into law.

For the past two years the executive committee named above have held frequent meetings at various places and visited Washington several times in the interests of the measure and have sent copies of the bill to interested parties thruout the country thus giving the measure publicity and calling the attention of Congress to the interests of their constituents in the measure. The agricultural press has taken a lively interest in the law and has given it considerable space. The passage of the law would have been much more difficult had it not been for the liberal financial support of the leading manufacturers who contributed liberally to the expenses of the committee, the total contributions amounting to $750.00 of which $206.67 still remains in the treasury.

Altho during the Sixtieth Congress there was some slight opposition by a certain element among the insecticide manufacturers, this

disappeared during the present session and no opposition whatever developed against the bill before Congress.

It is believed that this measure will aid very greatly in the standardization of the leading insecticides and fungicides and in deterring many parties from marketing worthless or fraudulent insecticides.

It is to be earnestly hoped that any states which may pass legislation along this line will frame their laws as closely as possible in the language and with the standards of the national law as this will tend to uniformity and will greatly aid the manufacturers in labelling their goods. It would seem that with this national law there would be but little call for additional legislation in most states, but where state laws are deemed necessary there is every reason for uniformity.

E. D. SANDERSON, *Chairman.*

[At the request of the chairman, the law is reproduced below.—Ed.]

SIXTY-FIRST CONGRESS

[PUBLIC—No. 152.]

[S. 6131.]

An Act For preventing the manufacture, sale, or transportation of adulterated or misbranded Paris greens, lead arsenates, and other insecticides, and also fungicides, and for regulating traffic therein, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That it shall be unlawful for any person to manufacture within any Territory or the District of Columbia any insecticide, Paris green, lead arsenate, or fungicide which is adulterated or misbranded within the meaning of this Act; and any person who shall violate any of the provisions of this section shall be guilty of a misdemeanor, and shall, upon conviction thereof, be fined not to exceed two hundred dollars for the first offense, and upon conviction for each subsequent offense be fined not to exceed three hundred dollars, or sentenced to imprisonment for not to exceed one year, or both such fine and imprisonment, in the discretion of the court.

SEC. 2. That the introduction into any State or Territory or the District of Columbia from any other State or Territory or the District of Columbia, or from any foreign country, or shipment to any foreign country, of any insecticide, or Paris green, or lead arsenate, or fungicide which is adulterated or misbranded within the meaning of this Act is hereby prohibited; and any person who shall ship or deliver for shipment from any State or Territory or the District of Columbia to any other State or Territory or the District of Columbia, or to a foreign country, or who shall receive in any State or Territory or the District of Columbia from any other State or Territory or the District of Columbia, or foreign country, and having so received, shall deliver, in original unbroken packages, for pay or otherwise, or offer to deliver, to any other person, any such article so adulterated or misbranded within the meaning of this Act, or any person who shall sell or offer for sale in the District of Columbia or any Territory of the United States any such adulterated or misbranded insecticide, or Paris green, or lead

arsenate, or fungicide, or export or offer to export the same to any foreign country, shall be guilty of a misdemeanor, and for such offense be fined not exceeding two hundred dollars for the first offense, and upon conviction for each subsequent offense not exceeding three hundred dollars, or be imprisoned not exceeding one year, or both, in the discretion of the court: *Provided*, That no article shall be deemed misbranded or adulterated within the provisions of this Act when intended for export to any foreign country and prepared or packed according to the specifications or directions of the foreign purchaser: but if said articles shall be in fact sold or offered for sale for domestic use or consumption, then this proviso shall not exempt said article from the operation of any of the other provisions of this Act.

SEC. 3. That the Secretary of the Treasury, the Secretary of Agriculture, and the Secretary of Commerce and Labor shall make uniform rules and regulations for carrying out the provisions of this Act, including the collection and examination of specimens of insecticides, Paris greens, lead arsenates, and fungicides manufactured or offered for sale in the District of Columbia or in any Territory of the United States, or which shall be offered for sale in unbroken packages in any State other than that in which they shall have been respectively manufactured or produced, or which shall be received from any foreign country or intended for shipment to any foreign country, or which may be submitted for examination by the director of the experiment station of any State, Territory, or the District of Columbia (acting under the direction of the Secretary of Agriculture), or at any domestic or foreign port through which such product is offered for interstate commerce, or for export or import between the United States and any foreign port or country.

SEC. 4. That the examination of specimens of insecticides, Paris greens, lead arsenates, and fungicides shall be made in the Department of Agriculture, by such existing bureau or bureaus as may be directed by the Secretary, for the purpose of determining from such examination whether such articles are adulterated or misbranded within the meaning of this Act; and if it shall appear from any such examination that any of such specimens are adulterated or misbranded within the meaning of this Act, the Secretary of Agriculture shall cause notice thereof to be given to the party from whom such sample was obtained. Any party so notified shall be given an opportunity to be heard, under such rules and regulations as may be prescribed as aforesaid, and if it appears that any of the provisions of this Act have been violated by such party, then the Secretary of Agriculture shall at once certify the facts to the proper United States district attorney, with a copy of the results of the analysis or the examination of such article duly authenticated by the analyst or officer making such examination, under the oath of such officer. After judgment of the court, notice shall be given by publication in such manner as may be prescribed by the rules and regulations aforesaid.

SEC. 5. That it shall be the duty of each district attorney to whom the Secretary of Agriculture shall report any violation of this Act, or to whom any director of experiment station or agent of any State, Territory, or the District of Columbia, under authority of the Secretary of Agriculture, shall present satisfactory evidences of any such violation, to cause appropriate proceedings to be commenced and prosecuted in the proper courts of the United States, without delay, for the enforcement of the penalties as in such case herein provided.

SEC. 6. That the term "insecticide" as used in this Act shall include any substance or mixture of substances intended to be used for preventing, de-

stroying, repelling, or mitigating any insects which may infest vegetation, man or other animals, or households, or be present in any environment whatsoever. The term "Paris green" as used in this Act shall include the product sold in commerce as Paris green and chemically known as the aceto-arsenite of copper. The term "lead arsenate" as used in this Act shall include the product or products sold in commerce as lead arsenate and consisting chemically of products derived from arsenic acid (H_3AsO_4) by replacing one or more hydrogen atoms by lead. That the term "fungicide" as used in this Act shall include any substance or mixture of substances intended to be used for preventing, destroying, repelling, or mitigating any and all fungi that may infest vegetation or be present in any environment whatsoever.

SEC. 7. That for the purpose of this Act an article shall be deemed to be adulterated—

In the case of Paris green: First, if it does not contain at least fifty per centum of arsenious oxide; second, if it contains arsenic in water-soluble forms equivalent to more than three and one-half per centum of arsenious oxide; third, if any substance has been mixed and packed with it so as to reduce or lower or injuriously affect its quality or strength.

In the case of lead arsenate: First, if it contains more than fifty per centum of water; second, if it contains total arsenic equivalent to less than twelve and one-half per centum of arsenic oxid (As_2O_5); third, if it contains arsenic in water-soluble forms equivalent to more than seventy-five one-hundredths per centum of arsenic oxid (As_2O_5); fourth, if any substances have been mixed and packed with it so as to reduce, lower, or injuriously affect its quality or strength: *Provided, however*, That extra water may be added to lead arsenate (as described in this paragraph) if the resulting mixture is labeled lead arsenate and water, the percentage of extra water being plainly and correctly stated on the label.

In the case of insecticides or fungicides, other than Paris green and lead arsenate: First, if its strength or purity fall below the professed standard or quality under which it is sold; second, if any substance has been substituted wholly or in part for the article; third, if any valuable constituent of the article has been wholly or in part abstracted; fourth, if it is intended for use on vegetation and shall contain any substance or substances which, although preventing, destroying, repelling, or mitigating insects, shall be injurious to such vegetation when used.

SEC. 8. That the term "misbranded" as used herein shall apply to all insecticides, Paris greens, lead arsenates, or fungicides, or articles which enter into the composition of insecticides or fungicides, the package or label of which shall bear any statement, design, or device regarding such article or the ingredients or substances contained therein which shall be false or misleading in any particular, and to all insecticides, Paris greens, lead arsenates, or fungicides which are falsely branded as to the State, Territory, or country in which they are manufactured or produced.

That for the purpose of this Act an article shall be deemed to be misbranded—

In the case of insecticides, Paris greens, lead arsenates, and fungicides: First, if it be an imitation or offered for sale under the name of another article; second, if it be labeled or branded so as to deceive or mislead the purchaser, or if the contents of the package as originally put up shall have been removed in whole or in part and other contents shall have been placed in

such package; third, if in package form, and the contents are stated in terms of weight or measure, they are not plainly and correctly stated on the outside of the package.

In the case of insecticides (other than Paris greens and lead arsenates) and fungicides: First, if it contains arsenic in any of its combinations or in the elemental form and the total amount of arsenic present (expressed as per centum of metallic arsenic) is not stated on the label; second, if it contains arsenic in any of its combinations or in the elemental form and the amount of arsenic in water-soluble forms (expressed as per centum of metallic arsenic) is not stated on the label; third, if it consists partially or completely of an inert substance or substances which do not prevent, destroy, repel, or mitigate insects or fungi and does not have the names and percentage amounts of each and every one of such inert ingredients plainly and correctly stated on the label: *Provided, however*, That in lieu of naming and stating the percentage amount of each and every inert ingredient the producer may at his discretion state plainly upon the label the correct names and percentage amounts of each and every ingredient of the insecticide or fungicide having insecticidal or fungicidal properties, and make no mention of the inert ingredients, except in so far as to state the total percentage of inert ingredients present.

SEC. 9. That no dealer shall be prosecuted under the provisions of this Act when he can establish a guaranty signed by the wholesaler, jobber, manufacturer, or other party residing in the United States, from whom he purchased such articles, to the effect that the same is not adulterated or misbranded within the meaning of this Act, designating it. Said guaranty, to afford protection, shall contain the name and address of the party or parties making the sale of such articles to such dealer, and in such case said party or parties shall be amenable to the prosecutions, fines, and other penalties which would attach in due course to the dealer under the provisions of this Act.

SEC. 10. That any insecticide, Paris green, lead arsenate, or fungicide that is adulterated or misbranded within the meaning of this Act and is being transported from one State, Territory, or District, to another for sale, or, having been transported, remains unloaded, unsold, or in original unbroken packages, or if it be sold or offered for sale in the District of Columbia or any Territory of the United States, or if it be imported from a foreign country for sale, shall be liable to be proceeded against in any district court of the United States within the district wherein the same is found and seized for confiscation by a process of libel for condemnation.

And if such article is condemned as being adulterated or misbranded, within the meaning of this Act, the same shall be disposed of by destruction or sale as the said court may direct, and the proceeds thereof, if sold, less the legal costs and charges, shall be paid into the Treasury of the United States, but such goods shall not be sold in any jurisdiction contrary to the provisions of this Act or the laws of that jurisdiction: *Provided, however*, That upon the payment of the costs of such libel proceedings and the execution and delivery of a good and sufficient bond to the effect that such articles shall not be sold or otherwise disposed of contrary to the provisions of this Act or the laws of any State, Territory, or District, the court may by order direct that such articles be delivered to the owner thereof. The proceedings of such libel cases shall conform, as near as may be, to the proceedings in admiralty, except that either party may demand trial by jury of any issue of fact joined in any

such case, and all such proceedings shall be at the suit of and in the name of the United States.

SEC. 11. That the Secretary of the Treasury shall deliver to the Secretary of Agriculture, upon his request, from time to time, samples of insecticides, Paris greens, lead arsenates, and fungicides which are being imported into the United States or offered for import, giving notice thereof to the owner or consignee, who may appear before the Secretary of Agriculture and have the right to introduce testimony; and if it appear from the examination of such samples that any insecticide, or Paris green, or lead arsenate, or fungicide offered to be imported into the United States is adulterated or misbranded within the meaning of this Act, or is otherwise dangerous to the health of the people of the United States, or is of a kind forbidden entry into or forbidden to be sold or restricted in sale in the country in which it is made or from which it is exported, or is otherwise falsely labeled in any respect, the said article shall be refused admission, and the Secretary of the Treasury shall refuse delivery to the consignee and shall cause the destruction or any goods refused delivery which shall not be exported by the consignee within three months from the date of notice of such refusal under such regulations as the Secretary of the Treasury may prescribe: *Provided*, That the Secretary of the Treasury may deliver to the consignee such goods pending examination and decision in the matter on execution of a penal bond for the amount of the full invoice value of such goods, together with the duty thereon, and on refusal to return such goods for any cause to the custody of the Secretary of the Treasury, when demanded, for the purpose of excluding them from the country, or for any other purpose, said consignee shall forfeit the full amount of the bond: *And provided further*, That all charges for storage, cartage, and labor on goods which are refused admission or delivery shall be paid by the owner or consignee, and in default of such payment shall constitute a lien against any future importation made by such owner or consignee.

SEC. 12. That the term "Territory," as used in this Act, shall include the District of Alaska and the insular possessions of the United States. The word "person," as used in this Act, shall be construed to import both the plural and the singular, as the case demands, and shall include corporations, companies, societies, and associations. When construing and enforcing the provisions of this Act, the act, omission, or failure of any officer, agent, or other person acting for or employed by any corporation, company, society, or association, within the scope of his employment or office, shall in every case be also deemed to be the act, omission, or failure of such corporation, company, society, or association, as well as that of the other person.

SEC. 13. That this Act shall be known and referred to as "The insecticide Act of 1910."

SEC. 14. That this Act shall be in force and effect from and after the first day of January, nineteen hundred and eleven.

Approved, April 26, 1910.

NOTES ON THE PUPATION AND HIBERNATION OF TACHINID PARASITES[1]

By W. R. THOMPSON

The question of the pupation of Tachinid parasites is one which has been found to present itself very frequently to those engaged in the researches in progress at the Gipsy Moth Parasite Laboratory, both on account of its biological interest and its practical importance. Very closely connected with the subject of pupation and in some cases bound up with it is that of hibernation. A short résumé of our knowledge in regard to these phases of the biology of Tachinids will, it is hoped, be of interest and possibly of some service to those who have encountered the discouraging results which have been often met with here in attempts to breed various species of these parasites through to maturity.

I am indebted to Mr. W. F. Fiske for suggesting the preparation of this paper, and for permission to use the data accumulated at the laboratory, for much of which data he is personally responsible.

Pupation. The general process of pupation among the Tachinidæ is, of course, well known. With very many species it occurs as follows: When the maggot has finished feeding upon the body of its host, and has established itself in surroundings of a suitable nature, it contracts, assuming a regularly ovoid form, the larval skin becomes smooth, gradually infiltrated with a dark pigment and of a hard and resistant character. Histolysis of the larval tissues then sets in and the development of the fully formed adult parasite is accomplished with more or less rapidity. The minute details of the developmental process cannot be considered here but on the other hand there are a number of variations in the process of pupation of a more general and not less interesting character which may be discussed in some detail. The most important of these variations are those which arise from a difference in the reaction of the parasite to the inimical influences to which it is subject in the pupal stage.

There are two classes of destructive agencies to which Tachinid parasites are subject in the pupal period. These are as follows: (1) Secondary parasitism; (2) Meteorological influences. It is, of course, apparent that most, if not all, Tachinids will be subject in exactly the same degree to secondary parasitism if equally exposed to it. On the contrary, this is not by any means true of their reaction to meteorological influences so that the forms which we have studied are

[1] Occasional contributions from the Gipsy Moth Parasite Laboratory, IV.

found to group themselves into two classes according to the effect which exposure to the last-named conditions has upon them. These classes may be described as follows:

(1). Those which habitually and of necessity enter the earth to pupate. (These being the forms upon which meteorological conditions exert a great influence.)

(2). Those which do not habitually and of necessity enter the earth to pupate, or do not do so in order to avoid the influences which affect the parasites of the first class.

It must be admitted that by characterizing the two divisions in this manner the difference between them does not appear to be very strongly marked. This is due in part to a very considerable variation in the habits of the parasites of the second class and some explanation is needed to make clear the compact nature of each group.

Whether or no the pupation of the Tachinid larva in the soil is of vital importance to it seems to be determined largely by, first, the duration of the pupal period and, second, the condition of the hibernating nymph within the puparium. In respect to the first mentioned factor it may be stated that while with all of the parasites of the first class the pupal period is of long duration this is sometimes also the case with those of the second class. The second factor is the important one as we shall now try to make clear.

Pupation of Tachinids of the first class. The pupation of these forms is characterized by the rapidity of the development of the pupa up to a certain point. Histolysis of the larval tissues and the development of the nymph to the stage where the external structures, such as the eyes, antennæ, macrochætæ, legs, wings and other appendages are as perfectly developed as they are in the fly on the point of issuing from the puparium, is accomplished frequently within thirty days after the formation of the puparium, and always long before the winter sets in. Among the forms which develop in the manner described may be mentioned *Blepharipa scutellata* Rdi. (R. D.), *Crossocosmia sericariæ* Rdi., and *Parasetigena segregata* Rdi., all important parasites of the gipsy moth. In the condition described the Tachinids are peculiarly susceptible to meteorological influences, especially in so far as these induce the drying up of the nymph within the puparium. From a large number of the puparia of *Blepharipa scutellata* and *Crossocosmia sericariæ* received at the laboratory in 1908 which were forced to pupate out of earth on account of the conditions under which the parasitized pupæ of the gipsy moth were shipped from Europe and Japan, and which were kept during the winter in cold but dry conditions, an issuance of less than one per

cent was secured the following spring. That this drying out of the nymph within the puparium, resulting in its death, is in some way correlated with its rapid development to an advanced stage long before it is ready to emerge, there can be but little doubt. No reasons for this rapid development can, of course, be given, nor can we definitely state the physiological reasons for the susceptibility of the parasite in this stage to dryness although it seems probable that the greater activity of the organs of the nymph means the requirement and giving off of a great deal of moisture from its body. At all events, an examination of puparia formed under natural conditions in woodland soil, and dug up in early spring, has disclosed the fact that the nymphs are normally subject to almost semi-aquatic conditions. The spaces between the pupal exuvium and the pupa, and between the pupal exuvium and the wall of the puparium were alike filled with a clear watery liquid.

The Tachinid larvæ seem to be instinctively aware of the danger of pupation under aërial conditions. In spite of the care now taken to send parasitized material from abroad in cold storage, it not infrequently happens that numbers of the maggots of *Blepharipa scutellata* and the two other species mentioned above, emerge from the pupæ of the gipsy moth in the shipping boxes en route. The puparia which these maggots form have been observed to be very often imperfect, larviform or nearly so, and usually not giving the fly. To determine the cause of the formation of such imperfect puparia and the conditions under which the larvæ could best pupate, an experiment with fresh maggots was undertaken in 1909. A number of these which had just emerged from gipsy moth pupæ were placed upon the surface of the soil in a shaded woodland, while others were allowed to pupate under various artificial conditions. The larvæ placed upon the soil descended into it very rapidly and formed perfect puparia in a short time. Little of interest could be deduced from the observations as to the pupation of the maggots under the various artificial conditions until the results thus obtained were compared with those secured by permitting the maggots to pupate in the soil when it at once became clear that in general, pupation is much retarded, a great irregularity in the length of the prepupal period is caused and that the maggots sometimes die without pupating, when prevented from entering the earth. So well developed is the instinct of the Tachinid maggots of the first class to seek the earth and bury themselves in it, that if a number of the pupæ of the gipsy moth which contain the larvæ of Blepharipa be confined in cardboard boxes, the maggots upon emerging from the pupæ will at once burrow down to

the bottom of the box and crawling about until they strike a corn, or by means of vigorous efforts with the mouth hook and muscular contractions of the powerful body, they will often manage to make a small hole through cardboard of considerable thickness and escape. Under such circumstances, a maggot is able to force itself through an opening so small that if an effort be made to remove it forcibly when it is part way out, the death of the parasite will generally result, although left to itself it can work through successfully. This propensity of the maggot to burrow downward and seek the earth has been utilized in a device, the invention of Mr. W. F. Fiske, for handling pupæ of the gipsy moth which contain the maggots of Blepharipa or Crossocosmia. These are placed upon a piece of mosquito netting stretched over a cylinder of earth into which it is desired that the maggots shall pupate, and through which they descend upon emerging from the host pupæ, falling upon the earth and at once entering it to pupate. A small cylindrical wire screen cage tightly fitting within the top of the cylinder containing the earth catches the moths and any summer-issuing parasites as they emerge. When it is certain that no more parasites will emerge the cylinder is covered up and buried in some moist cool spot after which it needs no further attention until spring.

In the experiment with the larvæ of Blepharipa cited above, it was noted that the larvæ which were placed upon earth, after descending for a few inches, turned about and proceeded to pupate with the anterior end directed upward. This position of the puparium has been observed at the laboratory in connection with other Tachinids, and also with Muscids and Sarcophagids and is very probably the usual mode of pupation among those species of Calyptrate Muscids which form their puparia in the soil. It is, of course, designed to facilitate the emergence of the fly from the earth in the spring, as the latter reaches the surface by the alternate expansion and contraction of the ptilinum, that organ being provided with many backwardly directed spines which serve to draw the fly upward through the earth.

Pupation of Tachinids of the second class. The Tachinid parasites of the second class have presented themselves much more frequently in our work than those of the first class, and they are undoubtedly of more general occurrence. They may be sub-divided as follows: (1) Those with a long pupal period; (2) Those with a short pupal period. The first group includes those forms which having but a single generation annually, hibernate in the pupal stage, but there must also be included in it those species of the second sub-division

which although they have several generations annually, hibernate in the pupal stage, which is in consequence much longer than in the summer broods. All of these Tachinids, although they resemble those of the first class in the long duration of the pupal period, differ from them in that they can pupate out of earth and withstand exposure to aërial conditions throughout the long period of hibernation, without the drying up and death of the nymph. This ability to withstand adverse meteorological conditions is accompanied by and undoubtedly correlated with a condition of the hibernating nymph very different from what we have described in regard to the species of the first class. In these species the initial development of the nymph proceeds very slowly, and by the time when low temperatures arrest the vital processes it has only developed far enough so that the general form of the pupa is apparent, none of the appendages being structurally developed. The nymphs of this sort can always be recognized by their creamy white color and differ markedly from those of the first class. Although the wall of the puparium formed by the species of this group is often much thinner than that of the puparium of Blepharipa for example, the nymph, as has been already remarked, can withstand exposure to aërial conditions and successfully complete its development. How well the nymph is protected against drying influences may be illustrated by the following example: a puparium of *Parexorista chelonia* Rdi., one of the Tachinids included in the first sub-division of the second class, which had pupated at the bottom of a box containing masses of brown-tail moth cocoons from a field colony, was kept in a glass vial in the laboratory during the winter. In early spring, as some of the other puparia kept under such conditions had already produced flies, while this had failed to do so, the anterior end of the puparium was removed, without breaking the pupal exuvium, to examine the condition of the nymph within. As it appeared to be in fairly good condition, it was left in the vial, and at the time when this article was written, about two months later, development had progressed to the point where the pilosity of the eyes, the antennæ and macrochætæ of the front and face were perfectly developed. There is in fact little doubt that the fly will shortly emerge in spite of the unusually adverse circumstances with which it has had to contend. The practical value of this point became apparent in the work with this species. As it is probably the most important European Tachinid parasite of the brown-tail moth, its puparia are received here in large numbers in the imported masses of brown-tail moth cocoons. The fact that the Tachinid can pupate and hibernate successfully under aërial

conditions makes it possible to avoid the tedious and expensive methods necessary with Blepharipa and Crossocosmia, to which would be added the painful and disagreeable task of a close examination of the masses of brown-tail moth cocoons in order to secure all of the puparia of this species so that they might be buried in earth and kept moist during the winter.

As to the physiological reasons for the ability of this species and those of the same habit to withstand exposure, no more can be said than that if the advanced stage of development of the hibernating nymphs of the parasites of the first class renders them susceptible to drying influences, than contrariwise, on account of the undeveloped state and slight activity of the internal organs of these forms, they do not require so much moisture nor do they give up their moisture content so readily. Although they can thus pupate and hibernate out of the soil, some of them, as we have observed in the case of *Varichæta aldrichii* Towns., habitually descend into the earth to pupate if they can easily do so. It is, of course, impossible to deny that long exposure to very dry conditions may have a detrimental effect upon certain individuals, but it seems more likely that they pupate in the soil in order to avoid the parasitic and predatory enemies to which they would be exposed for so long a time, did they remain unprotected upon the surface of the earth.

The parasites of the second sub-division pupate in various ways which seem to be determined more by the condition of the host and the individuality of the parasite than by the factors which influence the pupation of the parasites of the first class. Some of them, among which may be mentioned *Eudoromyia magnicornis* Zett., and *Zygobothria nidicola* Towns., pupate within the empty skin of the host which tightly encases the puparium. In this situation they are no doubt to a certain extent protected from secondary parasites. The wall of the puparia of these species is, so far as we have observed, quite thin and delicate, the skin of the host serving the same purpose as does the thicker wall of the puparia of the species which pupate freely. There are also other species, such as *Tricholyga grandis* Zett., *Tachina mella* W., and *Euphorocera claripennis* Macq., which pupate loosely within either the empty host skin or the pupa. These frequently occur to the number of three or four within a single host whereas *magnicornis* and *nidicola* are nearly always solitary. Moreover they do not always pupate in the manner above described but sometimes emerge from the body of the prepupal caterpillars or from the pupa, pupating either within the cocoon of the host if there is such, or leaving it and dropping to the ground. The wall of the

puparia is much thicker than in *magnicornis* and *nidicola*. If these forms pupate loosely within the skin of the caterpillar, within the empty pupa of the latter or within its cocoon, they are very liable to the attacks of secondary parasites, as the studies of the parasites of the tussock moth have demonstrated. It is almost certain to avoid these secondary parasites and such predators as ants, which often work great havoc among unprotected puparia, that they sometimes descend into the earth to pupate, as we have observed that *Tricholyga grandis* occasionally does. On the other hand we have noticed that fresh maggots of *Pales pavida* Rdi., when placed upon earth often manifest no desire to descend into it but pupate upon the surface. The short duration of the pupal period among some of these forms probably makes pupation in the soil of rather minor importance since they are only for a short time exposed to drying influences and to secondary parasitism.

Still other species such as *Frontina frenchii* Will., as a parasite of cecropia pupate well protected within the thick cocoon of the host from which they make no effort to emerge. The parasite mentioned is frequently found in the spring in very large numbers within the cocoon of cecropia, the puparia sometimes occurring to the number of forty or more. These puparia are in some cases very thin-walled and light in color. This phenomenon we have observed to vary directly as the number of puparia present, and there can be little doubt but that it is due rather to the inadequacy of the food supply, than to such an adaptation of the species to the environment as is found in the case of *magnicornis*. This is rendered the more probable since in a study of the reproductive habits of this species we have noticed that these thin-walled and light-colored puparia produce flies which are short-lived and which do not generally develop to maturity.

Hibernation. The factors which restrict hibernation among Tachinid parasites to a definite stage in the life history, or permit of a variation in this particular appear to be the habit of the host, and individuality of the parasite. As a general rule parasites with but a single generation annually hibernate in a certain stage and in a definite manner; on the other hand, those which have several generations in a season may pass the winter in various ways. Among the single-brooded species there are some with which the specific habit of the parasite is the controlling factor rather than the habit of the host. Such forms usually hibernate in the nymphal stage within the puparium. The condition of the hibernating nymph may be either undeveloped, as in *Varichæta aldrichii* and *Parexorista cheloniæ*, or advanced, as in *Blepharipa scutellata* and *Crossocosmia sericariæ*. This

phase of the question has been discussed already under "Pupation."

Another group of Tachinid parasites, which probably have but one generation annually, are those which pass the winter within the body of the living host. Of these we have observed but a few examples, but they are of exceptional interest. One of these forms is *Zygobothria nidicola* Towns., which as a parasite of the brown-tail moth, passes the winter as a first stage maggot in the hibernating larva of its host. It is evident that in this case the factor controlling the stage in which the Tachinid shall hibernate is the very small size of the over-wintering larva of the brown-tail. Were the parasite to feed only until it had reached the second stage, the death of the host would almost certainly result immediately, or it would be so weakened that it would perish during the winter, in which cases the Tachinid would also succumb. The larva therefore remains quiescent within the body of the host until the latter has fed for some time in the spring.

Another instance of hibernation within the living host has been found to occur in the case of an undetermined Tachinid parasite of *Euchaetias egle*. The development of this parasite, which we have found in very small caterpillars, is very slow, and the maggot passes the winter in the second stage within the hibernating pupa of the host, its larval life cycle occupying over eight months. In the spring it completes its larval development and emerges to pupate. It seems evident that this adjustment of the life cycle of the parasite to correspond with that of the host must be of advantage to it, otherwise it would complete its development within the host in the autumn and pass the winter in the pupal stage.

As has been indicated above, it seems probable that both of these species are single-brooded as the larval stage is of such long duration, but it is impossible to say so definitely. In the present state of our knowledge in regard to these subjects it is dangerous to draw many deductions. It will, in fact, be rather surprising if subsequent discoveries do not upset some of the generalizations which we have ventured to make.

One of the most interesting modes of hibernation which we have yet discovered has been found with some forms which pass the winter as third stage larvæ within the dry and otherwise empty skin of the host, emerging therefrom and pupating in the spring. This method of hibernation we have so far observed only with two undetermined species, one a parasite of *Datana* sp., the other infesting a European caterpillar, which is possibly *Cnethocampa processionea*. The condition of the hibernating larvæ is characteristic and worthy of remark. They are of a golden yellow color, this color being very probably due

to the fatty reserve material which they contain and the skin is of a hard firm texture. The larvæ in this respect resemble those of certain Sarcophagids which as we have observed, are able to remain alive in dry receptacles without food for several months, owing to the impermeable nature of their integument and the great amount of adipose tissue which they contain.

The hibernating habits of the Tachinids which we know to be several-brooded seem to be more variable in character within the species than is the case with the single-brooded forms. With these species there are at the beginning of the period of pupation individuals of the same species in different stages, this being a phenomenon of common occurrence among several-brooded insects in general, of which it is not necessary to explain the causes. Moreover, among a number of individuals of the same species some complete their development and emerge during the summer, while others undergo a suspension of the vital activities in the larval or pupal stage. These forms have as a rule many hosts. Among them may be mentioned *Tachina mella, Frontina aletiæ* Riley, and *Compsilura concinnata* Meig. The first two of the Tachinids mentioned have received considerable study as parasites of the tussock moth, and it was noted by Doctor Howard[1] that from a number of puparia of the second species mentioned, which were secured during the summer of 1895, the majority of the flies issued from September 19 to October 15 of the same year, but a single specimen issued April 16, 1896. Doctor Howard remarks that, "The usual method of hibernation here must be also in the imago stage although in the case of the fly which issued April 16 the puparium must have over-wintered. With these conclusions we fully agree, having observed the same phenomenon to occur in the case of *Tachina mella* and *Exorista amplexa* Coq., as parasites of the tussock moths. In Mr. Coquillet's "Revision of the Tachinidæ" a number of records are given of the issuance of *Euphorocera claripennis* from larvæ collected the preceding season, although it is not clear from the data presented whether the Tachinids passed the winter as puparia or in some of the larval stages. Similar records are given for *Winthemia quadripustulata, Sturmia inquinita* v. d. W., *Frontina frenchii,* and several other species. In the cases of this sort which have come under our notice we have found that the parasites hibernate as undeveloped nymphs within the puparia in the same manner as does *Parexorista cheloniæ.* The advantage of this mode of hibernation to the parasite is quite apparent. A number of the

[1] 1897. L. O. Howard. A Study in Insect Parasitism. Bull. No. 5, Tech. Series, Bur. of Ent. p. 43.

parasites of the tussock moth always elect to pupate within the cocoons of the host and among these there are some which do not emerge until the following year. Exposed as they are to meteorological conditions, if their nymphal development continued to the stage which it attains in *Blepharipa scutellata* before hibernation commenced, they would stand small chance of passing the winter successfully.

The most remarkable example of the entrance of certain individuals into hibernation, while others complete their development much more rapidly, has been found in the case of *Compsilura concinnata*, which is a several-brooded European parasite of the gipsy moth and other hosts. In experiments which we have conducted with this species and *Hyphantria textor* we have found that although some of the parasites finished their larval development and emerged from the host caterpillar within a short time, others attempted to hibernate as first stage larvæ within the pupa of the webworm. Less frequently, we have found *concinnata* hibernating in the same stage in the over-wintering brown-tail moth caterpillars in somewhat the same manner as does *Zygobothria nidicola*. Pantel, in his fine work, "Recherches sur les Diptères a larves entomobies," has noted what is probably the same thing with *concinnata* as a parasite of Pieris. He says: "In a lot of chrysalids of Pieris collected in autumn, of which some were unparasitized and others infested by Compsilura, there was a division: some butterflies emerged before the winter, their development following the æstival type, but the eclosion of others was retarded until spring. Now, the parasite behaves in exactly the same manner: some individuals finish their larval development in some days and emerge to pupate, while others will only emerge at the end of the winter or in spring." Although the author does not indicate precisely that the larva of *concinnata* hibernates in the first stage, there can be little doubt, from remarks which he has made previously in the same paper, that this is what occurs. Pantel attributes the singular behavior of the parasite to seasonal influences, especially those of temperature. It seems that this will scarcely explain the matter satisfactorily. To begin with, it is difficult to imagine that conditions of temperature should affect so markedly the length of the life cycle in certain individuals, without influencing that of others which are in precisely the same conditions. The question also presents itself: what would happen to the parasite should it elect to hibernate in the first larval stage in a caterpillar which invariably developed to the adult stage before the advent of winter? To avoid admitting the possibility of such an occurrence one would be forced to the conclusion that certain

but not all of the larvæ of this species were affected in a definite manner by hosts which pass the winter in the larval or pupal stage. Such a reaction between host and parasite, if it exists, must be of a most subtle and complex character, and it would be quite useless at the present time to speculate upon its nature.

It would be interesting to know whether any of the individuals which, as Pantel states, "finish their larval development in some days and emerge to pupate," pass the winter in the nymphal stage within the puparium, which he does not clearly explain, although he remarks that the pupal period varies from 13–16 days in summer, to 30–60 in winter, which makes it seem probable that some of the parasites might in some cases hibernate as nymphs. We have never observed such an occurrence here although we have handled large numbers of the puparia, which were, however, an earlier brood than the one of which Pantel speaks.

The hibernation of *Frontina frenchii* as a parasite of cecropia has been already discussed in an earlier paper on the parasites of the Saturniidæ. It seems very likely that this parasite often hibernates in both the puparium or adult stages. As a parasite of cecropia, on the other hand, it hibernates within the living pupa of the host in large numbers, reaching the third larval stage and emerging to pupate within the cocoon of the moth in early spring. While this resembles the mode of hibernation of the Tachinid parasite of Euchætias in general it is worthy of separate mention as it offers an example of the change in the habits of a many-brooded species, whose life cycle is ordinarily quite short, whereby it adapts itself to the conditions found in a host hibernating in the pupal stage, and thus secures a more advantageous method of hibernation.

It seems likely that many species of Tachinids hibernate in the adult stage. The abundance of many forms late in the autumn, many of them females almost fully mature sexually, seems to indicate it. We have, moreover, observed such mature females of one of the European parasites studied which attempted to hibernate and this when they might have deposited their eggs had they so desired. If such a habit is at all common, it is more than likely that the fertilized females alone survive the winter. In our researches we have always found that the life of the male is shorter than that of the female and that its ability to withstand adverse conditions is not so great.

Although it is impossible to explain the variations in the hibernating habit which we have indicated, the general reason for their existence is very clear. They are evidently natural safeguards to prevent the extinction of the species in that they give it more opportunities

for passing successfully through the most critical period in its life history, the period of hibernation. That such variation has not yet been found within the species which have but one generation annually is not especially strange. With such forms the host relations and the character of the life processes are fairly definite and restricted, and all of the individuals of the species usually develop to about the same stage by the beginning of winter, whereas in the many-brooded, polyphagous species, there are often at the beginning of the season of hibernation specimens in several stages which must get through the winter as best they can. This we imagine to be the cause of the curious and varied methods of hibernation which have developed in these forms.

Conclusion. It is quite certain that only a small beginning has been made in the study of the interesting phases of the biology of Tachinid parasites which have been discussed in this short paper. It is hoped that the few data which we have thus far accumulated will be of some interest in themselves. They have in addition a certain practical value, for in the study of any injurious insect a knowledge of its parasitic enemies is desirable. In the case of Tachinids this is sometimes difficult to obtain because failure to rear the parasite to maturity renders its specific determination impossible. This difficulty has been encountered here, more especially on account of a lack of knowledge of the habits of the Tachinids which hibernate in an advanced nymphal stage, which must be provided with conditions as closely approximating the natural as can be devised. Since it is impossible to predict what the habits of a given species may be, all the forms which are met with must be allowed to pupate under the best possible conditions. The method which up to the present has given the most satisfactory results is as follows: Wire screen cylinders are constructed of brass or copper screen, having preferably not less than twenty meshes to the inch. These cylinders may be of varying sizes but it is well to make them not less than six inches in length. They are filled with soil obtained in shaded woodland, a core of earth of the same size as the cylinder being cut out and transferred with as little disarrangement as possible. We have found that with such soil better results are obtained than with loose loam because the innumerable fine rootlets in the woodland soil prevent the maggot from descending very far before pupation. In loose loam, on the other hand, it may burrow down for a considerable distance before pupation, and the settling of the soil above the puparium during the winter may make it difficult or impossible for the fly upon emerging to reach the surface. On this account, too, it is a good plan to pack

quite firmly the earth in the cylinders. They may then be fumigated with carbon bisulphide to kill any creatures which might attack the puparia of the Tachinids, and when they have been afterward thoroughly aired, the Tachinid larvæ as they emerge from their hosts, may be placed in them and allowed to pupate as they wish. This may be facilitated by placing material suspected to contain Tachinids upon a piece of mosquito netting stretched above the earth in a cylinder in the manner already described earlier in this paper. The cylinder may then be sunk in the ground in some cool, moist place, examined from time to time in the summer to secure the summer-issuing species and again the next spring for the hibernating forms. The essential thing is that the earth in which the maggots have pupated be kept moist during the winter in order to successfully rear the hibernating species. With the forms which hibernate within the body of the over-wintering host, the methods which suffice to carry the latter to maturity will suffice for the parasites. It is only necessary to recognize that such hibernating hosts may contain Tachinid parasites whose habits and identity it is well to determine.

FOOD OF THE BOBWHITE

By MARGARET MORSE NICE, *Clark University, Worcester, Mass.*

INTRODUCTORY

To become effective, conservation of our valuable bird life must be based on definite knowledge of the facts. To gather the facts requires patient study, and the present paper gives the results of more than two years research and presents the most complete and convincing statement that we have of the food of any bird. As these results become generally known, by sheer weight of values involved, they will put the bobwhite, properly appreciated and protected, in every farm and garden in the land.

This paper forms a part of a more complete monograph on the Biology of the Bobwhite, which aims to discuss the species in all its complex relations to the life of the continent. Two general points, however, may be anticipated.

First, former researches have demonstrated that the bobwhite feeds almost entirely on weed seeds and insects, and that it does no appreciable damage to agriculture. Some may ask for a more detailed analysis of the insect food and may question whether the bird may not take valuable insects to such an extent as to decrease somewhat

the account in its favor. To do our work we are at liberty to [illegible] among the many forces of living nature those most effective, most easily controlled and most agreeable. On all these counts, for destruction of weed seeds and insects, the bobwhite leaves nothing to be desired. A bird that takes so many injurious insects is welcome to the beneficial ones as well. Apparently, if we could have enough bobwhites, they would leave nothing for the beneficial insects to do.

Second, the tendency at present, over a large portion of its natural range is strongly toward extinction of the bobwhite. To reverse this tendency will require careful study of the problems involved and vigorous and concerted effort. It is generally recognized that extermination of natural enemies is the beginning of game protection. For the bobwhite, cats go farther toward accounting for scarcity and extinction of the birds than sportsmen and all other natural enemies combined. Crows, rats, skunks, weasels, minks and several of the hawks and owls, especially the three first, are enemies which must be controlled, if the species is to increase anywhere, or if the birds are even to hold their own; and no one should attempt to introduce stock for the purpose of colonization until the ground has been thoroughly gone over and all vermin exterminated. Although protected by cages, cats have repeatedly broken up nests by frightening off the brooding birds at night, and in one instance a cat disturbed a pair with a brood of fifteen chicks and all but three were dead next morning, chilled in the wet grass. One such occurrence shows that the damage a cat may do is only limited by the number of birds she is able to find. She might as easily have scared up a dozen broods in a night as one, and still, with cats ranging at will everywhere, we pretend to wonder why the bobwhite is so scarce.

The paper is, further, an illustration of the possibilites of investigating the food of a species by the feeding test method. The striking feature is the quantitative results, the day's works, but qualitatively also the fact that so many species could be added to the dietary of a bird already so carefully studied by the method of crop examination suggests that the feeding test method may with profit be applied to many species of birds. The method is sure to yield in the near future much more complete results on the side of insects destroyed. In fact, many species of insects were eaten, as they were swept up in the nets, that were not definitely identified.

The present paper is printed in the hope of educating the public and of furnishing support for the strong movement already afoot for the more adequate protection of the bobwhite. It would seem that all who read it must agree with the author's conclusion:

"If we were wise enough as a people to protect and increase our weed-destroying and insectivorous birds, they should largely control these enemies of our crops. Bobwhites, if we only had enough of them, ought to save us more than half of our $17,000,000 weed damage and of our billion dollar insect tax."

C. F. HODGE.

The experiments have been carried on since September, 1907, in Worcester, Mass., with birds that had been under domestication three and four generations. The original stock came from Kansas, Alabama and South Carolina. Eighteen birds of the third generation were used, chiefly for weed tests; some were hatched under hens, some in an incubator; all were raised in brooders. A special study was made in 1908 of one bobwhite of the next generation.

WEED SEEDS

Dr. Sylvester Judd of the Bureau of Biological Survey has made a careful study of the food of the Bobwhite by analysis of stomach contents. In his bulletin "The Bobwhite and Other Quails of the United States in their Economic Relations" he says:

"The bobwhite is preëminently a seed eater, 52.83 per cent of its food for the year consisting of seeds. The bulk of these are the seeds of plants belonging to the general category of weeds. The food of no other bird with which the writer is acquainted is so varied." (6)

"The laboratory work to determine the different kinds of food and their proportions has included examination of crops and gizzards from 918 birds. This material was collected from 21 States, Canada, the District of Columbia, and Mexico, but chiefly from New York, Maryland, Virginia, Florida, Illinois, South Dakota, Nebraska, Kansas, and Texas. Stomachs were obtained each month of the year, but unfortunately few were collected in the breeding season. Laboratory work included also feeding experiments with three pairs of captive bobwhites obtained from Kansas." (7)

In my experiments the weeds or merely the seeds were put into the cages, to see whether the birds would eat them. By this means 61 weeds were added, making 129. Dr. Judd's contributions to the following list are starred.

WEED SEEDS EATEN BY BOBWHITE

*Barbed panicum.....*Panicum barbatum.*
*Barnyard grass, barn grass, cocksfoot, water grass.....*Panicum crusgalli.*
*Bastard pennyroyal.....*Trichostema dichotomum.*

*Beggarticks, bur marigold, pitchforks, stick seed.....*Bidens* sp.
*Bindweed, bear bind, English bindweed, morning glory.....*Convolvulus arvensis.*
*Black bindweed.....*Polygonum convolvulus.*
Black mustard, brown mustard, grocer's mustard.....*Brassica nigra.*
Blue vervain, simpler's joy.....*Verbena hastata.*
Blue weed.....*Echium vulgare.*
Boneset, ague weed, fever weed, thoroughwort .....*Eupatorium perfoliatum.*
Bouncing Bet, hedge pink, soapwort....*Saponaria officinalis.*
Bracted plaintain, western plaintain...*Plantago aristata.*
Bull thistle, bird thistle, boar thistle, pasture thistle.....*Carduus lanceolatus.*
Burdock, beggar's buttons, gobo, great dock .....*Artium lappa.*
Butter and eggs, toadflax, devil's flax, snapdragon .....*Linaria linaria.*
*Button weed, compass weed, poor weed..*Diodia teres.*
Canada thistle, creeping thistle, cursed thistle .....*Carduus arvensis.*
*Carpet weed, Indian chickweed.....*Mollugo verticillata.*
*Charlock, wild mustard, yellow mustard .....*Raphanus raphanistrum.*
*Chickweed, common chickweed.....*Alsine media.*
Chicory, savory.....*Chicorium intybus.*
*Climbing false buckwheat, bindweed....*Polygonum scandens.*
Cinquefoil .....*Potentilla canadensis.*
Common darnel .....*Lolium temulentum.*
*Corn cockle, bastard nigella, cockle, rose campion.....*Agrostemma githago.*
*Corn gromwell, field gromwell, red root, wheat thief.....*Lithospermum arvense.*
*Crab grass, finger grass, Polish millet..*Panicum sanguinale.*
*Creeping bush clover.....*Lespedeza repens.*
*Croton .....*Croton* sp.
*Crownbeard .....*Verbesina* sp.
*Curled dock, sour dock, yellow dock....*Rumex crispus.*
Dandelion .....*Taraxicum taraxicum.*
Darnel .....*Festuca elatior pratensis.*
Dodder .....*Cuscuta gronovii.*
Evening primrose .....*Œnothera biennis.*
*Everlasting .....*Antennaria* sp.
False flax, gold of pleasure, Siberian oilseed, wild flax.....*Camelina sativa.*
False nettle .....*Bochmeria cylindrica.*
Fireweed .....*Erechtites hieracifolia.*
*Flowering spurge, showy spurge.....*Euphorbia corollata.*
Fringed black bindweed.....*Polygonum cilinode.*

*Giant ragweed, hogweed, horseweed, tall ragweed ..... *Ambrosia trifida.*
*Green foxtail, green pigeon grass, bottle grass..... *Chætochlia viridis.*
*Gromwell ..... *Lithospermum officinale.*
*Hairy bush clover..... *Lespedeza hirta.*
Hedge mustard ..... *Sisymbrium officinale.*
*Hoary puccoon ..... *Lithospermum canescens.*
*Hoary vervain ..... *Verbena stricta.*
Horse nettle, bull nettle, radicle, sand briar ..... *Solanum carolinense.*
Horseweed, butterweed, colt's tail, fleabane ..... *Erigeron canadense.*
Ironweed ..... *Vernonia noveboracensis.*
*Japan Clover ..... *Lespedeza striata.*
*Jewel weed, touch-me-not..... *Impatiens* sp.
Joe-Pye weed, trumpet weed..... *Eupatorium purpureum.*
*Knotweed, doorweed, goose grass..... *Polygonum aviculare.*
*Lamb's-quarters, goosefoot, pigweed.. *Chenopodium album.*
*Lupine ..... *Lupinus* sp.
*Marsh elder, false ragweed, false sunflower, high-water shrub..... *Iva xanthifolia.*
Mayweed, dog fennel, stinking chamomile ..... *Anthemis cotula.*
Meadowsweet ..... *Spiræa salicifolia.*
Milk purslane, spotted spurge..... *Euphorbia maculata.*
Milkweed, silkweed, wild cotton..... *Asclepias syriaca.*
Morning glory ..... *Ipomœa* sp.
Motherwort ..... *Leonurus cardiaca.*
Mouse-ear chickweed..... *Cerastium vulgatum.*
Mullein, Aaron's rod, flannel plant, velvet dock..... *Verbascum thapsus.*
Nightshade, deadly or black-berried nightshade ..... *Solanum nigrum.*
Nonesuch, black medick, medicago..... *Medicago lupulina.*
Nut grass, coco, coco sedge, nutsedge... *Cyperus rotundus.*
Old witch grass ..... *Panicum capillare.*
Orange hawkweed, devil's paint brush, golden hawkweed ..... *Hieracium aurantiacum.*
Ox-eye daisy, bull's-eye, white daisy, white weed ..... *Chrysanthemum leucanthemum.*
Partridge pea ..... *Chæmocrista fasciculatis.*
Pennsylvania persicaria..... *Persicaria pennsylvanica.*
Pepper grass ..... *Lepidium virginicum.*
Persicaria, pale..... *Persicaria lopathifolia.*
Pigeon grass, pussy grass, summer or yellow foxtail ..... *Chætochloa glauca.*
Pigweed, redroot, rough amaranth..... *Amaranthus retroflexus.*
Plantain, white man's foot..... *Plantago major.*
Poison ivy, poison vine..... *Rhus radicans.*
Pokeweed, garget, pigeon berry, skoke.. *Phytolacca decandra.*

Prickly lettuce, strong-scented lettuce..*Lactuca virosa.*
Purslane, garden purslane, pursley, pusley .....*Portulaca oleracea.*
Rabbit's-foot clover, stone clover.....*Trifolium arvense.*
*Ragweed, bitterweed, hogweed, Roman wormwood, richweed .....*Ambrosia artemisiæfolia.*
*Ribgrass, black plantain, buck horn, deer tongue.....*Plantago lanceolata.*
Rough avens.....*Geum virginianum.*
Round-headed bush clover.....*Lespedeza capitata.*
Round-leafed mallow, cheeses, mallard .....*Malva rotundifolia.*
Russian pigweed.....*Axyris amarantoides.*
*Sedge .....*Carex* sp.
*Sensitive pea.....*Chæmocrista nictitans.*
*Sheathed rush grass.....*Sporobolus vaginæflorus.*
Shepherd's purse, mother's heart, pickpurse, toothwort.....*Bursa bursa-pastoris.*
*Sida .....*Sida spinosa.*
*Skunk cabbage.....*Spathyema fœtida.*
Skunk tail grass.....*Hordeum jubatum.*
*Slender finger grass.....*Syntherisma filiformis.*
*Slender paspalum.....*Paspalum setaceum.*
*Slender spike grass.....*Uniola laxa.*
*Smartweed .....*Polygonum hydropiper.*
*Sorrel: field, horse, red or sheep sorrel; sour weed .....*Rumex acetosella.*
*Spreading panicum.....*Panicum proliferum.*
Spurry .....*Spergola arvensis.*
Steeplebush .....*Spiræa tomentosa.*
Sticktight, beggar's lice.....*Lappula virginiana.*
Stinkweed, penny-cress, French weed..*Thlaspi arvense.*
St. John's wort.....*Hyperium perforatum.*
*Sunflower .....*Helianthus annuus.*
Sweet grass.....*Hierochloë borealis.*
*Switch grass, tall smooth panicum.....*Panicum virgatum.*
Tearthumb .....*Polygonum sagittatum.*
*Texas croton.....*Croton texensis.*
*Three-seeded mercury, copper-leaf.....*Acalypha glacilens.*
*Tick-trefoil .....*Meibomia grandiflora.*
*Tick-trefoil .....*Meibomia nudiflora.*
*Trefoil .....*Lotus* sp.
*Tussock sedge.....*Carex stricta.*
*Vetch .....*Vicia* sp.
Water hoarhound.....*Lycopus americanus.*
Water smartweed.....*Polygonum acre.*
White vervain, nettle-leaved vervain...*Verbena stricta.*
Wild carrot, bird's nest, lace weed, Queen Anne's lace.....*Daucus carota.*
Wild oats.....*Avena fatua.*
Wild rice .....*Zizania aquatica.*

Witch grass.....*Agropyron repens.*
Yarrow, milfoil.....*Achillea millefolium.*
Yellow daisy, brown-eyed Susan, cone flower.....*Rudbeckia hirta.*
*Yellow sorrel.....*Oxalis stricta.*

Feeding Habits

Another experiment was an attempt to bring up a bobwhite in an entirely natural way so far as weeds were concerned. When he was a month old, he was taken into the garden or fields every few days, and watched to see what he would eat. He was given no weed seeds until after he had found and eaten them out-of-doors. He would experiment on many things that were not eatable, and if he had been out for half a day instead of less than an hour at a time, and if he had been taken to more places to find weeds, undoubtedly he would have eaten a greater variety.

The following seeds were his special favorites:

Barnyard grass.
Chickweed.
Pigeon grass.
Ragweed.
Yellow sorrel.

He was also fond of

Cinquefoil.
Lamb's quarters.
Peppergrass.
Pigweed.
Plantain.
Rabbit's foot clover.
Red sorrel.

In regard to the number of seeds of certain weeds that a bobwhite will eat at a meal, Dr. Judd has several records of the amounts found in single crops. In a few cases I watched a bird eat all that he wanted counting while he ate.

Chickweed	2,025	2,250	Russian pigweed	350
*Crab grass	1,000		*Smartweed	300
*Lamb's quarters		10,000	*Sorrel	550
*Pigeon grass		5,000	Stinkweed	105
*Pigweed		400	Sweet grass	200
*Ragweed		1,000		

In order to find out how many seeds of one kind a bobwhite would eat in a day the following tests were made. A weighed amount of

clean weed seeds was put into a box, which was set inside a larger box so that any seed scratched out would be caught and all that the birds did not eat, weighed. One gram of each kind of seed was counted. Two birds were used in each feeding test; they had nothing but green food to eat besides the weed seeds.

NUMBER OF SEEDS EATEN BY A BOBWHITE IN A DAY

Barnyard grass	2,500	Milkweed	770
Beggar ticks	1,400	Peppergrass	2,400
Black mustard	2,500	Pigweed	12,000
Burdock	600	Plantain	12,500
Crab grass	2,000	Rabbit's foot clover	30,000
Curled dock	4,175	Round headed bush clover	1,800
Dodder	1,560	Smartweed	2,250
Evening primrose	10,000	White vervain	18,750
Lamb's quarters	15,000	Water smartweed	2,000

To quote again from Dr. Judd:

"A careful computation of the total amount of weed seed the bobwhite is capable of destroying is surprising in the magnitude of its result. In the State of Virginia it is safe to assume that from September 1 to April 30, the season when the largest proportion of weed seed is consumed by birds, there are four bobwhites to the square mile, or 169,800 in the entire State. The crop of each of these birds will hold half an ounce of seed, and as at each of the two daily meals weed seed constitutes at least half the contents of the crop, or a quarter of an ounce, a half ounce daily is certainly consumed by each bird. On this very conservative basis the total consumption of weed seed by bobwhites from September 1 to April 30 in Virginia amounts to 573 tons." (8)

The following tests were made in order to ascertain how much bobwhites eat each day.

Four birds ate	60	grams of weed seeds in one day.	Indoors, in November.
Two birds ate	30	" " " " " " "	" " "
One bird ate	16.5	grams of weed seeds and grain.	Indoors, in December
One bird ate	17	" " " " " " "	" " October.
One bird ate	14	" " " " " " "	" " "
One bird ate	20	" " " " " " "	" " "
One bird ate	15	" " " " " " "	" " "
One bird ate	14	" " " " " " "	" " "
One bird ate	21	" " " " " " "	" " "
One bird ate	17	" " " " " " "	" " "
One bird ate	14	" " " " " " "	" " "
One bird ate	12	" " " " " " "	" " "
One bird ate	17	" " " " " " "	" " "

One bird ate 17 grams of weed seeds and grain. Indoors, in October.
One bird ate 12 " " " " " " " " "
One bird ate 13 " " " " " " " " "
Twelve birds ate 180 grams of grain in one day. Outdoors, in February.
Twelve birds ate 180 grams of weed seeds in one day. Outdoors, in February.
Twelve birds ate 180 grams of grain in one day. Outdoors, in February.

The average of these tests is 15 grams, a little more than half an ounce.

Insects

"The bobwhite eats insects in every month of the year. Moreover the large proportion of injurious insects habitually eaten renders the services of this bird more valuable than those of many birds whose percentage of insect food, though greater, includes a smaller proportion of injurious species. Conspicuous among the pests destroyed are the Colorado potato beetle, twelve-spotted cucumber beetle, bean leaf-beetle, squash ladybird, wireworms and their beetles, and May beetles. Its food also includes such weevils as corn billbugs, imbricated snout beetle, clover leaf weevil, cotton boll weevil; also the striped garden caterpillar, army worm, cotton bollworm, and various species of cutworms; also the corn-louse ants, red-legged grasshopper, Rocky Mountain locust, and chinch bug." (9)

The most important insects added by my experiments are the squash bug, plant lice, the cabbage butterfly, cankerworms, codling moth, the Hessian fly, the mosquito, stable fly, and the typhoid fly.

LIST OF INSECTS EATEN BY THE BOBWHITE.

Thysanura
Silver fish.....*Lepisma saccharina.*
Ephemerida
*May flies.....
Orthoptera
*Cricket .....*Gryllus* sp.
*Meadow grasshoppers.....*Xiphidium.*
*Meadow grasshoppers.....*Orchelimum.*
*Meadow grasshoppers.....*Scudderia.*
*Katydid .....*Microcentrum* sp.
*Walking sticks.....*Phasmidæ.*
*Grouse locust.....*Tettix* sp.
*Rocky Mountain locust.....*Melanoplus spretus.*
*Red-legged grasshopper.....*Melanoplus femur-rubrum.*
*Grasshopper .....*Melanoplus bivittatus.*
*Grasshopper .....*Melanoplus scudderi.*
*Grasshopper .....*Melanoplus atlanis.*
*Bird grasshopper.....*Schistocerca americana.*
Hemiptera
Heteroptera
*Chinch bug.....*Blissus leucopterus.*
*False chinch bug.....*Nysius angustatus.*

*Three-spotted soldier bug.....*Euschistus tristigmus.*
*Stink bug.....*Euschistus variolarius.*
*Stink bug.....*Euschistus* sp.
*Bug .....*Podisus* sp.
*Bug .....*Brochymena* sp.
*Bug .....*Nezara hilaris.*
*Bug .....*Mormidea lugens.*
*Bug .....*Hymenarcis nervosa.*
*Bug .....*Hymenarcis æqualis.*
*Bug .....*Thyanta custator.*
*Bug .....*Œbalus pugnax.*
*Bug .....*Trichopepla semivittata.*
*Bug .....*Cænus delius.*
*Bug .....*Peribalus limbolarius.*
*Tarnished plant bug.....*Lygus pratensis.*
*Bug .....*Corimelæna* sp.
*Bug .....*Apiomerus crassipes.*
*Bug .....*Alydus carinus.*
*Bug .....*Corizus* sp.
*Bug .....*Euthocta galeator.*
*Shield-backed bugs.....*Scutelleridæ.*
Squash bug.....*Anasa tristis.*

Homoptera

*Leaf hopper.....*Oncometopia lateralis.*
*Leaf hopper.....*Oncometopia* sp.
*Leaf hopper.....*Deltocephalus* sp.
*Leaf hopper.....*Diedrocephala* sp.
Plant lice.....*Aphididæ.*
Tree hoppers.....*Membracidæ.*

Lepidoptera

*Army worm.....*Heliophila unipuncta.*
*Cutworm .....*Agrotis* sp.
*Cutworm .....*Feltia annexa.*
*Noctuid moth.....*Noctuidæ.*
*Cotton worm.....*Alabama argillacea.*
*Cotton bollworm.....*Heliothis obsoleta.*
*Striped garden caterpillar.....*Mamestra legitima.*
*Yellow bear caterpillar.....*Diacrisia virginica.*
*Pyralid .....*Tholeria reversalis.*
*Purslane sphinx.....*Deilephila gallii.*
*Southern tobacco worm.....*Phlegethontius sexta.*
*Caterpillar .....*Junonia cœnia.*
*Pupa .....*Vanessa* sp.
Cabbage butterfly .....*Pieris rapæ.*
Canker worms.....*Anisopteryx.*
Tent caterpillar.....*Clisiocampa americana.*
Bee moth .....*Galleria melonella.*
Codling moth.....*Carpocapsa pomonella.*
Clothes moth.....*Tinea pellionella.*

Diptera

*Crane fly .....*Tipulidæ.*

*Green fly.....*Lucilia cæsar.*
*Robber fly.....*Asilidæ.*
Mosquito.....*Culex.*
Mosquito.....*Anopheles.*
Hessian fly.....*Mayetiola destructor.*
Typhoid fly.....*Musca domestica.*
Stable fly.....*Stomoxys calcitrans.*

Coleoptera

Carabidæ

*Ground beetle.....*Scarites subterraneus.*
*Ground beetle.....*Amara* sp.
*Ground beetle.....*Casnonia pennsylvanica.*
*Ground beetle.....*Platynus extensicollis.*
*Ground beetle.....*Agonoderus pallipes.*
*Ground beetle.....*Harpalus pennsylvanicus.*
*Ground beetle.....*Harpalus caliginosus.*
*Ground beetle.....*Anisodactylus rusticus.*
*Ground beetle.....*Anisodactylus baltimorensis.*

Chrysomelidæ

*Leaf beetle.....*Cryptocephalus venustus.*
*Leaf beetle.....*Colaspis brunnea.*
*Leaf beetle.....*Nodonota tristis.*
*Leaf beetle.....*Chrysomela pulchra.*
*Leaf beetle.....*Chrysomela suturalis.*
*Leaf beetle.....*Œdionychis fimbriata.*
*Leaf beetle.....*Disonycha 5-vittata.*
*Leaf beetle.....*Disonycha xanthomelæna.*
*Leaf beetle.....*Disonycha crenicollis.*
*Leaf beetle.....*Psylliodes punctulata.*
*Leaf beetle.....*Microrhopala vittata.*
*Three-lined potato beetle.....*Lema trilineata.*
*Colorado potato beetle.....*Leptinotarsa decemlineata.*
*Bean leaf beetle.....*Ccrotoma trifurcata.*
*Striped cucumber beetle.....*Diabrotica vittata.*
*Twelve-spotted cucumber beetle....*Diabrotica 12-punctata.*
*Locust leaf-mining beetle.....*Odontota dorsalis.*
*Golden tortoise beetle.....*Coptocycla bicolor.*
Elm-leaf beetle.....*Galerucella luteola.*

Scarabæidæ

*May beetle.....*Lachnosterna tristis.*
*Dung beetle.....*Onthophagus pennsylvanicus.*
*Dung beetle.....*Aphodius inquinatus.*
*Leaf-chafer.....*Diplotaxis* sp.
*May beetles.....*Serica* sp.
*May beetles.....*Anomala* sp.
*May beetles.....*Aphonus* sp.

Rhynchophora

*Imbricated snout beetle.....*Epicærus imbricatus.*
*Fuller's rose beetle.....*Aramigus fulleri.*
*Clover weevil.....*Sitones hispidulus.*
*Clover-leaf weevil.....*Phytonomus punctatus.*
*Mexican cotton boll weevil.....*Anthonomus grandis.*

*Billbug ..... *Sphenophorus parvulus.*
*Corn billbug ..... *Sphenophorus zeæ.*
*Weevil ..... *Thecesternus humeralis.*
*Weevil ..... *Tanymecus confertus.*
*Weevil ..... *Chalcodermus collaris.*
*Weevil ..... *Centrinus.* sp.

Elateridæ

*Click beetle ..... *Drasterius elegans.*
*Click beetle ..... *Agriotes* sp.
*Click beetle ..... *Melanotus communis.*
*Click beetle ..... *Corymbites* sp.

Coccinellidæ

*Lady beetle ..... *Hippodamia parenthesis.*
*Squash ladybird ..... *Epilachna borealis.*
*Lady beetle ..... *Coccinella sanguinea.*
*Lady beetle ..... *Adalia bipunctata.*

Histeridæ

*Histerid beetles .....

Tenebrionidæ

*Darkling beetle ..... *Blaptinus.*
Mealworms ..... *Tenebrio* sp.

Staphylinidæ

*Rove beetles .....

Lampyridæ

*Soldier beetle ..... *Chauliognathus pennsylvanicus.*

Cerambycidæ

*Longicorn beetle ..... *Tetraopes tetraophthalmus.*

Dermestidæ

Carpet beetle ..... *Anthrenus scrophulariæ.*

Hymenoptera

*Ants ..... *Lasius* sp.
*Ants ..... *Tetramorium cæspitum.*
*Ants ..... *Camponotus pennsylvanicus.*
*Gall flies ..... *Cynipidæ.*
*Parasitic wasps ..... *Tiphia inornata.*
*Parasitic wasp ..... *Proctotrypes rufipes.*
Rose slug ..... *Monostegia rosæ.*
Currant worm ..... *Pteronus ribesii.*

Other animal food

*Spiders .....
*Harvest spiders ..... *Phalangidæ.*
*Thousand leg ..... *Julus* sp.
Sow bug ..... *Oniscidæ.*
*Snail ..... *Pupa armifera.*
**Pond snail ..... *Succinea avara.*
*Crayfish ..... *Cambarus.*
*Toad .....

The following are a few records of the numbers of insects eaten by bobwhites at single meals.

*Grasshoppers: from 20 to 39.

Chinch bugs: 100, in another case two tablespoonfuls in a cup.

Squash bugs: 6, 11, 12.

Aphids: 2,326 eaten by a week old chick; this was more than one meal, but was not all his insect food for that day.

*Army worm: 12.

*Cutworm: 12.

Hessian fly flaxseeds: 20.

Mosquitoes: 144 — a week old bird; 568 — a nearly grown bird in three hours. In both these cases the supply gave out, while the birds were still eager for more.

*Potato beetles: 75, 101.

May beetle grubs: 7, 8.

*Cotton boll weevil: 47.

Sow bugs: 6.

Miscellaneous insects: 1,400 in half a day — a laying hen the 23rd of June.

Tests to ascertain how many insects of one kind a bobwhite might eat in an entire day gave the following results. The birds had plenty of weed seeds, grain and green food, except in two cases in which the fact is indicated.

5,000 aphids — chrysanthemum black fly. Adult bird in December. This is the only case in which the insects were not individually counted; one thousand were counted and the rest estimated.

1,350 flies. A laying hen in July. About one fifth were maggots, the rest adults.

59 adult potato beetles. A laying hen; test by Mazie Hodge.

1,286 rose slugs. A laying hen; test by Mazie Hodge.

37 grasshoppers and 2,400 seeds of pigeon grass eaten apiece by two six weeks old birds in October.

43 grasshoppers and 2,100 seeds of pigeon grass eaten apiece by two six weeks old birds in October.

20 grasshoppers and 3,000 seeds of pigeon grass eaten apiece by two six weeks old birds in October.

65 large crickets eaten apiece by two seven weeks old birds in October. They had no weed seeds or grain.

84 large and middle-sized grasshoppers eaten apiece by two seven weeks old birds in October. They had no weed seeds or grain.

700 insects — 300 of them grasshoppers. A laying hen in July. Their weight was 24 grams.

1,532 insects — 1,000 of them grasshoppers. A laying hen in July. Their weight was 24.6 grams.

Eight tests were made with an adult cock in October and November.

28 grasshoppers = 11g. 14g. of grain. Total — 25g.
33 grasshoppers = 15g. 13g. of grain. Total — 28g.
48 grasshoppers = 19g. 10g. of grain. Total — 29g.
22 grasshoppers = 12g. 16g. of grain. Total — 28g.
25 grasshoppers = 12g. 11g. of grain. Total — 23g.
23 grasshoppers = 12g. 8g. of grain. Total — 20g.
20 grasshoppers = 9g. 12g. of grain. Total — 21g.
25 grasshoppers = 11g. 10g. of grain. Total — 21g.

The average is:

28 grasshoppers = 12.5g. 12g. of grain. Total — 24.5g.

STUDY OF THE GROWTH AND FEEDING OF ONE BOBWHITE

At hatching weighed 6 g.					
5 days	8				
7	....		Ate 2826 aphids and 20 mealworms.		
8	10.5		Ate 7 grams of insects.		
9	12.5 g.	Increase 2.5			
10	13.	.5			
11	13.3	.3	Ate 330 insects.		
12	14.	.7			
13	15.	1.	Ate 514 insects.		
14	15.5	.5	225 insects = 8 g.		Ate 51% of his weight.
*15	15.	—.5	236	7	47%
*16	14.8	—.2	400	8	54%
*17	15.8	1.	200	8	50%
18	16.5	.7	351	8	48%
19	17.5	1.	411	6.6	38%
20	20.	2.5	354	10.1	50%
21	21.2	1.2	732	10	47%
22	22.5	1.3	287	10.4	46%
23	25.3	2.8	296	11	43%
24	26.2	.9	185	8	30%
25	28.5	2.3	250	12	42%
26	30.5	2.	393	9.3	30%
27	32.6	2.1	529	10.2	31%
28	34.2	1.6	710	13.5	42%
35	43.5				
36	46.5	3.			
37	49.5	3.	102	11. + 15 g. of grain = 26	= 52%
38	51.	1.5	112	11. + 12 g. of grain = 23	= 47%
39	53.	2.	134	12.5 + 12 g. of grain = 24.5	= 45%
44	67.	....	....		
49	77.	....	....		
54	91.	....	....		
55	92.	....	....		
At 10 weeks	123.	....	....		
11	139.	16.	....		
12	153.	14.	....		
13	158.	3.	...		
14	164.	8.	....		
15	166.	2.	....		

* The loss in weight is due to his having lice for three days.

At hatching he weighed 6 g.; in 9 days he had doubled in weight. In the next 2 weeks he had doubled again, and again at the end of another fortnight. It took him 3 more weeks then to weigh 96 g.; in the

last 8 weeks of his growth he gained 75 g. For the first 12 weeks his average gain per day was 1.75 g. The average daily gain each week was as follows: .5 g., .7 g., .8 g., 2.1 g., 1.6 g., 2.35 g., 2.4 g., 2.1 g., 2.1 g., 2.3 g., 2.3 g., 2 g. The next four weeks his growth was slow; the average daily gain each week was: .43 g., 1.1 g., .3 g., .7 g.

At 4 months he weighed 170 g. which is an average adult weight for him, although sometimes he has weighed from 12 to 19 grams more.

In every case he was weighed before he had had anything to eat. He always had all he would eat in the tests, but doubtless would have eaten somewhat more in a wild state, for he would have exercised more than he did when kept in confinement. I regret that I did not make feeding tests in the first two weeks of his life, but I do not think he ever ate more than two-thirds of his weight at the most. For the first two or three days the chicks eat little, as the unabsorbed yolk nourishes them. Charles W. Nash in "The Birds of Toronto" says:

"For the first two or three months of their lives young quail feed almost exclusively on insects, and each one will, while he is growing, consume nearly its own weight of them every day." (11)

Edward Harris states in "The Quail the Best Insect and Weed Exterminator Must be Better Protected" that:

"A young quail will consume its own weight in insects every day." (4)

My results do not agree with this. A bobwhite does not have to eat so much nor grow so fast as those birds that are helpless until they nearly reach adult size.

As a result of these tests I have made an estimate of the amount eaten by a bobwhite in a year.

First 2 weeks, 72 g.=10,245 insects. The 8th day he ate 7 g. Counting nothing for two days, we might assume he ate as follows: 4, 4, 4, 5, 6, 7, 7, 7, 7, 7, 7, 7,=72. In four of these days he ate 3,415 insects. At the same rate in twelve he would have eaten 10,245.

3rd and 4th weeks, 132 g.=5,334 insects. Actual tests.

5th week, 88g.=3,520 insects. His average weight for this week was 38.8. A third of that multiplied by 7 should give an estimate of the amount eaten. With 40 insects to the gram, as was the case in the two weeks before, the result is 3,520.

6th week, 81 g.=812 insects+91 g. grain. In 3 days he ate 34.5 g. =348 insects and 39 g. of grain. The week is calculated at the same rate.

Totals: 373 g.=10,911 insects+91 g. grain.

In December, January, February, March, April and half of November the estimate is that found by 56 tests — 15 g. of weed seeds a day.

ESTIMATE OF THE AMOUNT EATEN IN A YEAR

	By an adult hen		By an adult cock	
	Insects	Weeds	Insects	Weeds
January	.....	465 g.	.....	465 g.
February	.....	420	.....	420
March	.....	465	.....	465
April	90 g.	450	90 g.	450
May	372	372	372	372
June	600	300	372	372
July	620	310	372	372
August	620	310	372	372
September	450	300	372	372
October	372	372	372	372
November	186	411	186	411
December	.....	465	.....	465
	3310 g.	4640 g.	2508 g.	4908 g.

For the cock in May, June, July, August, September, October and half of November, and for the hen in May, October and half of November the estimate is that found by 8 tests in October and November —12 g. of each. In June, July and August when the hen is laying, 20 g. of insects seems a safe average. In 2 tests in July a hen ate 24 g. and 24.6 g. respectively.

For a young bird, if we substitute the figures for his first six weeks for six weeks of July and August in the adult cock's estimate, the result is 2,377 g. of insects and 4,495 g. of weed seeds.

An average of 45 tests gave 22.5 insects to a gram. The highest is 60 in July, the lowest 2 in November. This average is too low for the smallest insects that the birds eat, such as plant lice, were not weighed; besides for the tests large insects were often caught in preference to smaller ones for convenience sake.

One gram of 23 different kinds of seeds were counted; the average was 1,096.

Barnyard grass,	1,250	Evening's primrose,	2,000
Beggar's ticks,	200	Lamb's quarters,	1,000
Black bindweed,	300	Milkweed,	110
Black mustard,	500	Pepper grass,	3,000
Burdock,	100	Pigeon grass,	500
Crab grass,	500	Pigweed,	3,000
Curled dock,	835	Plantain,	2,500
Fringed black bindweed	250	Rabbit's foot clover,	2,000
Dodder,	780	Ragweed,	500

Round headed bush clover,	300	White vervain,	2,500
Smartweed,	900	Water smartweed,	200
Sorrel,	2,000		

Thus a bobwhite cock might eat on an average in one year 56,430 insects and 5,379,168 weed seeds; a hen 74,475 insects and 5,063,520 weed seeds and a young bird 65,001 insects and 4,926,520 weed seeds.

Estimates of the Annual Loss Due to Weeds and Insects.

It is impossible to make calculations as to how much a bobwhite's eating of these thousands of insects and millions of weed seeds is worth to us in dollars and cents. I quote, however, a few estimates of the annual losses due to weeds and insects, so that we may get more of an idea of the importance of the problem.

"Since the total value of our principal field crops for the year 1893 was $1,760,489,273, an increase of only 1%, which might easily have been brought about through the destruction of weeds, would have meant a saving to the farmers of the nation of about $17,000,000 during that year alone." (1) "The simple cost of weed removal along the railways of the State of Ohio is placed by Stair at over half a million dollars per annum." (13) "The weeds found in cornfields annually cost the farmer of Iowa many thousands of dollars." (12) "Minnesota produces annually about 200,000,000 bushels of small grain. A dockage of one pound per bushel (due to weeds) means a loss of 200,000,000 pounds. Had the land been free of weeds the same amount of plant food, moisture and labor would have produced over 3,000,000 bushels of wheat or the equivalent in other grains. This makes an annual loss due to weeds of about $2,500,000 or an annual rental of about 30 cents an acre on every acre on which small grain is grown. Added to this great loss we must include cost of fighting weeds, loss of fertility and moisture, strain on machinery, extra cost of twine to tie up the weeds, freight charges for shipping weeds, etc." (14) In Ontario the "Bureau of Industries for the Province in 1898 sent out a few questions about weeds to its regular correspondents, and others, chiefly those who had done satisfactory experimental work in connection with the Experimental Union. "A large number of answers were received. . . . A number estimate their loss at 25c per acre, and quite a few place it as high as $5 per acre; so considering the whole list and counting labor, with the loss of soil moisture, fertility, etc., we think that $1 per acre is a conservative estimate of the annual loss throughout the Province." (5)

C L. Marlatt in "The Annual Loss Occasioned by Destructive Insects in the United States" estimates the yearly tax chargeable to in-

sects in this country as $795,100,000. (10) "The common schools of the country cost in 1902 the sum of $235,000,000, and all higher institutions of learning cost less than $50,000,000, making the total cost of education in the United States considerably less than the farmers lost from insect ravages. . . . Furthermore, the yearly losses from insect ravages aggregate nearly twice as much as it costs to maintain our army and navy; more than twice the loss by fire; twice the capital invested in manufacturing agricultural implements; and nearly three times the estimated value of the products of all the fruit orchards, vineyards, and the small fruit farms in the country." (3) Prof. H. T. Fernald, Massachusetts State Entomologist, says: "Estimates of the annual loss by insects calculated at 18% are now considered as about correct, and this loss on the basis of the United States government crop estimates for 1906 would be considerably over a billion dollars each year." (2)

If we were wise enough as a people to protect and increase our weed destroying insectivorous birds, they should largely control these enemies of our crops. Bobwhites, if we only had enough of them, ought to save us more than half of our $17,000,000 weed damage, and of our billion dollar insect tax.

Summary

The bobwhite is known to eat 129 different kinds of weed seeds.

A single bird was found to eat as many as 12,000, 18,000 and 30,000 seeds of one kind of weed in a day.

They eat 15 grams, or half an ounce, of weed seed daily throughout the winter.

The known list of insects eaten — 135 — includes many of the most injurious species.

A single bird ate at one meal 568 mosquitoes; another during a day ate 1,350 flies; a third ate 5,000 plant lice, while still another record is 1,532 insects, 1,000 of which were grasshoppers.

Bobwhites eat from 12 to 24 grams of insects daily in the summer.

In a study of the growth and feeding of one bobwhite, it was found that in his third week he ate half of his weight of insects, in his fourth week one third. In the sixth the addition of grain brought it up to one half again. When adult they eat from one twelfth to one sixth of their weight.

An estimate of the average amount eaten by a bobwhite in a year is 2,732 grams, or about 5 pounds, of insects, and 4,681 grams, or about 9¾ pounds, of weed seeds, which are equivalent to 65,302 insects and 5,123,076 weed seeds.

I wish to acknowledge my indebtedness to Dr. C. F. Hodge of Clark University, under whose direction this work was done, for help and suggestions; to Mr. Arthur Merrill of the Massachusetts State Hatchery at Sutton, for assistance in rearing the birds; to Dr. F. M. Webster of the United States Bureau of Entomology, for supplying me with various insects; and to Mr. A. D. Selby of the Ohio Agricultural Experiment Station, and Mr. Geo. H. Clark, Seed Commissioner of the Department of Agriculture, Canada, for sending me weed seeds.

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A UNIQUE INSECT CATCHING MACHINE

By F. C. BISHOPP, *U. S. Bureau of Entomology, Dallas, Texas*[1]

The following article is published not because the observations are thought to have any particular value or that the machine described can be utilized practically in the control of the bollworm, but to call attention to a rather unusual digression in mechanical insect destroying devices and with the hope that the idea involved may be suggestive to workers in other entomological fields.

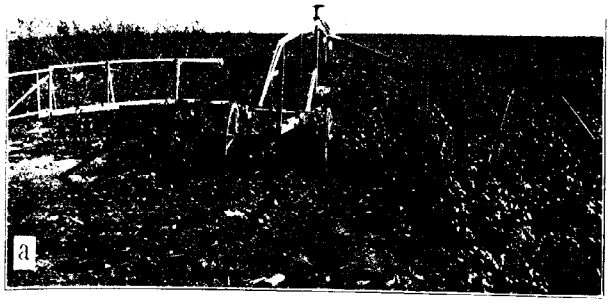
The machine illustrated herewith is the result of the ingenuity of a progressive Ellis County (Texas) farmer in his efforts to discover a method of controlling the bollworm (*Heliothis obsoleta* Fabr.) on cotton. Unlike most of the machines devised for use against the bollworm this one is designed to capture the adult moths instead of the larvæ. While lights are employed to concentrate and destroy the moths, the success of the apparatus is not dependent upon the normal attraction of the moths to light. The machine was evolved by Mr. T. A. Sissom, who is the inventor, from an observation made by him upon the habits of flight of the moths when disturbed at night. The writer has also observed that the majority of the moths when startled at night fly directly upward for several feet, apparently in an effort to avoid striking the cotton plants or other objects.

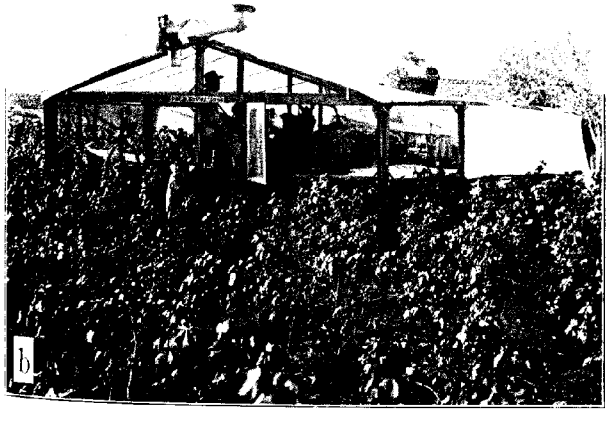
The machine consists of a framework mounted on four wheels. The frame is 36 feet wide in front, 18 feet wide at the back and 28 feet from the front to the back. This frame, except at the back, is covered with domestic, which can easily be put on or removed. The back is screened in.

The machine is pulled by a pair of horses or mules which are hitched between the fore and hind wheels under the canvas, the driver and operator sitting immediately behind the team. The guiding is done by simply rotating a wheel which controls the angle of the front axle.

The front part of the canvas extends down quite close to the cotton but not low enough to strike the plants and thus disturb the moths. Agitators in the form of sacks containing some heavy object, are attached to the frame a few feet back from the front edge of the canvas. These disturb the moths which fly up, strike the canvas and gradually drift toward the three lights at the back of the machine, as the apparatus moves forward. The back part of the machine has a floor high enough to pass over the cotton. This prevents the down-

[1] Published by permission of the chief of the Bureau of Entomology.





Insect Catching Machine: *a*. Front view of machine with cloth covering removed; *b*. Rear view of machine ready for operation; the seat on top may be occupied by a pilot if so desired.

ward escape of the moths when they reach the back of the machine. The upper one of the three lights, each of which has a reflector to throw the light ahead, is situated at the extreme back end of a tapering inverted trough made of screen. Just in front of this light is a large torch the flame of which scorches the insects as they pass backward over it to the stronger light behind. The bottom of the torch container is removed occasionally and the moths emptied into a bag and treated with kerosene to kill those not already dead.

On account of the free flight of the bollworm moths it is difficult to arrange a satisfactory practical test of such a machine on a limited area. During three successive nights in July a 40-acre field of cotton was gone over and 1,440, 2,000 and 860 moths were captured on the respective nights. An examination of the catch made in 3½ hours during the night of July 27th showed the following insects to have been captured: *Heliothis obsoleta* Fabr. 688 (409 females and 279 males), *Loxostege similalis* Guen. 157, *Calycopis cecrops* Fabr. 1, miscellaneous Lepidoptera 72 (including several injurious forms), *Chrysopa* sp. 1,906, Myrmeleonids 11, Tachinids 16, Syrphids 6, Tabanids 12, Sarcophagids 150, miscellaneous Diptera (small) several hundred, *Calacorus rapidus* Say 762, Tettigonids and Jassids (mostly *Bodrocephala coccinea* Forst.) 68, *Podisus maculiventris* Say 2, *Dobrotica 12-punctata* Fabr. 14, Elaterid 1, Bruchids 2.

It was found that many of the bollworm moths captured were newly emerged or gravid females, while with an ordinary trap light only males and exhausted females are usually caught.

It will be noted that a good many beneficial insects were captured notably 1,906 adult Chrysopas. I believe that the majority of these as well as other beneficial forms could be allowed to escape by putting in larger meshed wire at the back end of the machine. This would of course allow the escape of the smaller injurious insects as well.

Despite the large size of the apparatus it is manipulated with great ease except when the wind is blowing. A strong wind renders operation impossible. From 60 to 70 acres may be gone over in one night. Mr. Sissom informed me that the cost of constructing one of these machines is about $80.

As has been suggested it has not been demonstrated that this machine can be utilized practically in the control of the bollworm, but there is little doubt that some injury may be prevented where it is conscientiously used.

NOTES ON RHYNCHITES BICOLOR, FABR.

By EDGAR L. DICKERSON, *New Brunswick, N. J.*

In this Journal for December, 1909, page 467, Dr. B. N. Gates gives some notes on the abundance of *Rhynchites bicolor* in Massachusetts during the past season. The insect is recorded as common in New Jersey, throughout the state, but in our experience it is somewhat local in its distribution, being very abundant at some points and quite scarce at others. In some of the nurseries where we have had an opportunity of observing roses, in the course of inspection work, we have found little evidence of the insect. At New Brunswick, however, it occurs each year so abundantly on the *Rosa rugosa* hedge on the College Campus that there is scarcely a seed capsule which does not show one or more of its punctures. No effort has been made to breed the insect but certain observations have been recorded which it seems advisable to publish at this time.

As noted in other localities, the insect makes its appearance in May and continues through June and July and is observed first feeding in the buds or opened blossoms. In feeding in the buds the insect inserts its beak through the still closed petals, causing the puncture which becomes so conspicuous when the blossoms open. Rarely, feeding occurs in the tender tips of the shoots where as many as a dozen closely placed punctures have been observed in a single tip. Very few of these tips were found although their wilted appearance made them rather conspicuous. That they were caused by feeding seems quite evident from the fact that no eggs were found in the punctures although a careful search was made for them.

While I have no record of the beginning of oviposition, it continued for some time and in late June the beetles were noted both feeding in the open flowers and in copulation, and oviposition was in progress. The latter operation was observed on more than one occasion and noted to proceed in the following manner:

The work of making the puncture was continued until the full length of the beak — as far as the eyes — was inserted and the final part appeared to be the smoothing down of the sides of the puncture and enlarging the bottom; the whole operation taking somewhat over a quarter of an hour. In working the beetle spread its legs as if to brace itself and the antennæ were extended backward close together against the upper surface of the head. Having completed the puncture, the insect turned about, rested its anal extremity in the cavity and remained there for about half a minute while it oviposited. Then turning about again it spent slightly more than half a minute in

apparently pushing the egg down into the bottom of the cavity and covering the opening. In this operation the value of the ball and socket like connection of the head with the thorax was evidenced, for without changing its position the insect was able to move its head around from side to side. Whether the covering of the puncture is a secretion of the plant caused by the injury or in part is some secretion of the weevil is not quite evident. At any rate it forms a distinct covering, light in color at first and gradually darkening.

An examination of the seed capsule shows that the punctures extend through the outer covering and sometimes into the bases of the seeds, resting within it and measure 2 mm. in depth. The egg is oval in outline, measuring .9 mm. in length by .65-.70 mm. in width, and is light in color with a yellowish tinge given it by the contents. It rests in the bottom of the puncture with the longest diameter parallel with the direction of the cavity.

Punctures were found in the seed capsules of the blossoms as well as those from which the petals had fallen and as many as 8 were noted in a single one. On several instances two punctures were observed so close together that they extended into each other at their bases and in all such cases only a single egg was found, so that it appeared as if the first egg had been destroyed by the weevil, in the operation of making the second puncture.

Hatching of the eggs began the first of July and by the middle of the month most of them had hatched. No unhatched eggs were found on July 22 when a number of punctured seed capsules were examined, although a very few young larvæ were found as late as early September. The larvæ became well developed by August and soon after the middle of that month many full grown ones were found. By early September most of the larvæ had left the seed capsules, which in many cases had become hard and dry.

THE EFFECTS OF FUMIGATION WITH HYDROCYANIC GAS ON THE HUMAN SYSTEM

By W. W. YOTHERS, *Bureau of Entomology, U. S. Department of Agriculture*

Owing to the extremely poisonous nature of hydrocyanic gas, the literature on this subject contains many cautions in regard to its use. While I believe these are on the whole justifiable, they make the uninitiated unduly afraid of the dangers. I doubt if there has ever been a single death from fumigating—at least from fumigating orange trees. The experience of the workers on the White Fly Investigations of the Bureau of Entomology in Florida shows that only rarely

does the gas cause sickness. In the entire three seasons' work this occurred only five or six times.

In the winter of 1907–1908 in fumigating over three thousand trees eight hundred of which were large seedlings, two men quit work because the gas made them sick. These men operated the pulley ropes which lifted the edge of the tent from the ground and raised it to the top of the derrick. Just as soon as the edge of the tent is raised the gas comes out and the men who operate the pulley ropes being nearest the opening get more of the gas than the other men. The trees were very large, requiring from four to six pounds of cyanide. No note was made as to whether or not the night was calm or on the condition of the tents as to dampness which largely determines the leakage of gas during exposure.

Only one instance happened in the season of 1908–1909 in fumigating about a thousand trees. The night of January 11, 1909, was as far as one could determine absolutely calm. The trees were fairly large, requiring from two to four pounds of cyanide. We changed the tents every 40 minutes. The tents being somewhat damp were very tight so that little gas leaked out during the period of exposure. Five men became sick on this night. One of these emptied the residue from the crocks and held his head over the residue as it was being poured out so that he breathed the escaping gas. This, of course, was entirely unnecessary. The other four operated the pulley ropes as did the men who became sick in the tests of 1907–1908. Two became sick and were relieved by two others who also soon were affected.

On this night I relieved one of the men operating the pulley ropes. In a short time my heart beat much faster than the work seemed to justify, then dizziness overcame me and I stretched out under an orange tree. In about 5 minutes it became necessary to go to stool. After this a nauseating feeling remained for some time followed by chills and trembling of the muscles and almost total loss of muscular strength. A vicious headache terminated these symptoms. These symptoms were in the main common to all the affected persons. In one or two instances vomiting occurred.

In October, 1909, we were fumigating some trees about ten feet in height, using a 25 per cent increase over the dosage given in Bulletin 76 of the Bureau of Entomology and moving the tents every 25 minutes. The shortness of the exposure gave little time for the gas to leak out and also the tents were much tighter than those used on former occasions. There was no breeze. During the first night no one became sick although the gas was very strong. However, during the second night all of us got sick. One man fell over and the

rest of us were compelled to postpone the work for a few minutes. Our hearts thumped against our breast bones and one fellow vomited. All of us were well on the following morning and felt as if nothing had happened. On this night we did not realize the importance of hurrying away from the tent as soon as it was raised with the poles. It was unnecessary this time and could have been easily avoided.

The only object of writing these experiences is to enable one to tell when they are getting too much gas. If the heart beats very rapidly it is time to get away for a while. A small amount of gas is not uncomfortable to a fumigator and is seldom noticed at all. Sometimes a prolonged exposure to a small amount of gas causes coughing which is nothing serious. If tents are left on the trees the proper length of time and those men nearest the tent when first raised take proper precautions, there is little or no danger and the poisonous fumes do not interfere with the process at all.

Scientific Notes

Simulium and Pellagra.—We learn from the London *Times* through a recent issue of *Science*, that Dr. Sambon has proved that maize is not the cause of Pellagra, the blood thirsty *Simulium reptans* being responsible for the dissemination of this infection. It is hardly necessary to remind our readers that only a few years ago the important part played by Diptera in the dissemination of human diseases was practically unknown. The order must now be considered as one of the most important from an economic standpoint, especially because of the part flies play in the spread of disease.

Oyster Shell Scale (*Lepidosaphes ulmi* Linn.).—The paper on this insect by Mr. Cooley, was very interesting. We have entirely cleaned badly infested trees by spraying with a lime-sulfur wash and then failed on adjacent trees, no matter how carefully the application was made, though we usually succeeded in reducing the numbers of the pest. The experience of the last six years convinces us that the late spring application is by far the more effective. One season we treated about half an acre of large, imported lilacs which were nearly dead because of injury by the oyster shell scale. A very thorough application was given when the lilacs were in bloom, and an examination in the fall showed that 90% of the shrubs were free, the remainder having a few scales on one or two shoots only. An application of kerosene emulsion to 67 infested poplar trees resulted in practically cleaning the trees, as shown by an examination the following winter. C. R. NEILLIE, *Cleveland, Ohio.*

Larch Sawfly, a Correction.—I find that in the short paragraph of my paper on the Larch Sawfly (page 149) that the stenographic report is not quite what I said and is likely to mislead. I did not say that no males were present, but that larvæ were reared from females, no males being present: and that, in a total of several thousand specimens .3 per cent. were males and the rest females.

C. GORDON HEWITT.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

JUNE, 1910

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Reprints may be obtained at cost. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. The receipt of all papers will be acknowledged.—EDS.

We include in this issue, a paper extending somewhat beyond the scope of the JOURNAL, yet nevertheless of great interest to economic entomologists, since it gives in compact form, many very serviceable facts about an extremely valuable bird. The data upon its vegetarian food is so closely interrelated with its animal diet that it seemed inadvisable to attempt to separate the two. We are confident that many entomologists will find it very convenient to have this data accessible.

The passage of the Insecticide Act of 1910 marks an important and most timely advance in the right direction. Heretofore almost any compound containing arsenate of lead might be sold under that name. After January 1st next, all preparations of this recently developed and extremely valuable insecticide falling below a specified standard, are debarred from interstate commerce. The recent great advance in work with insecticides, accompanied by enormous increases in the demand for materials, has resulted in a number of manufacturers entering this field. We are convinced that the majority are content to place upon the market excellent preparations at moderate prices. Occasionally there is a rogue who preys more or less directly upon the reputation of others. For example, one brand of arsenate of lead sold in the local market under a trade name for twenty-five cents a pound contains only four to five per cent. of arsenic oxide, while another brand containing fourteen to fifteen per cent. arsenic oxide, sells for fifteen cents a pound. Many a man fails to discriminate between the two and accepts the dealers "just as good" at face value, apparently forgetting that there may be a large profit in pushing the lower grade goods. This substandard material, with the above mentioned national law in force, will soon be driven from the market or confined to a very limited field. Aside from the possibilities of fraud mentioned above, there is a great gain in establishing standards for recognized compounds. It prevents confusion and lessens the danger of unsatisfactory results following spraying operations.

Reviews

The **Hibernation of the Boll Weevil in Central Louisiana**, by WILMON NEWELL and M. S. DOUGHERTY, Louisiana Crop Pest Commission, Circ. 31, p. 163–219, 1909.

In 1905 and '06 the Louisiana Crop Pest Commission carried on extensive experiments on the hibernation of the boll weevil at Keachie, La., in coöperation with the Bureau of Entomology, which have been partially reported by Hinds and Yothers (Bull. 77 Bur. Entomology). Further experiments were felt to be necessary and these were arranged at Mansura, near the center of Louisiana in the fall of 1908. The authors are entirely warranted in their statements that "The results of these experiments from the standpoint of the Louisiana planter at least, are of far more practical importance than those of any like experiment previously made." The object was to determine what percentage of weevils survive the winter, and at what rate they left their winter quarters in the spring. A series of large wire screen cages 8 x 8 x 6 ft. high were constructed in which were placed materials in which the weevils commonly hibernate. From 1000 to 1200 weevils were placed in each cage. A series of cages was installed to determine the effect of starvation in the fall by enforced hibernation. The weevils were placed in the first cage September 28 and a similar cage was started each week until December 21. A comparison was also made of a cage under normal conditions and one located in a swamp in a light growth of timber. In another cage a large tree-limb bearing Spanish moss was placed to determine its value as a hibernating quarter.

It has been previously stated that the weevils seek hibernating quarters when a mean daily temperature falls to 60° F., but the authors' observations show that the weevils were not inclined to enter hibernation till December 8, altho the mean temperature for ten days preceding was 43°. The writers believe that some of the weevils seen on the sides of the cages remained there thruout the entire winter. In the five cages first started the greatest death rate occurred during the warm weather prior to the date of hibernation. Commencing on February 15, daily observations were made to determine the number of weevils leaving hibernation and these were tabulated in detail. In general, it may be said that the tabulation of the data and results of these investigations is most admirable and leaves nothing to be desired on the part of the student who wishes to give them detailed study.

In the 16 cages there were 16,281 weevils, 3,360 of which or 20.63 per cent survived the winter. As a result of a comparison of the percentage surviving in the cages in which the weevils were confined at different dates in the fall, it is shown that where cotton plants were destroyed before October 15, only 3 per cent survived; where it was destroyed between October 15 and 27, 15 per cent survived; from November 1 to 25, 22 per cent survived; from November 30 to December 7, 28 per cent survived, and if the destruction of the plants were postponed till after the middle of December, over 43 per cent survived.

It was found that in the average winter quarters 20 per cent of the weevils survive, but where Spanish moss was furnished, 27.96 per cent emerged from hibernation. A comparison of the cages placed in a swamp

and in normal conditions showed practically no difference in the mortality resulting.

The earliest weevil emerged on February 21; the last one on June 29, the period of emergence covering 129 days. The earlier the weevils were confined in the fall, the earlier the majority of them emerged in the spring. This shows very clearly the value of early destruction of the stalks in the fall in connection with poisoning with dry arsenate of lead as they are poisoned much more easily in the spring. It is shown that weevils hibernating in moss emerge much later than under natural conditions, 50 per cent emerging over a month later.

The same is true of weevils hibernating in swamps and it is shown that "the weevils hibernate in cool and shaded locations do not leave hibernation till the summer heat has risen sufficiently for these places to be warm to the temperature reached in the fields one to three weeks earlier."

The average time the weevils lived in hibernation without food was 156 days. The weevil which lived the longest without food was placed in a cage September 28 and emerged June 9, 255 days later. A detailed study of the relation of the time of emergence from hibernation to the time when the weevils were deprived of food in the fall, shows that when all cotton plants are destroyed by October 1st the average weevil must live 183 days without food before emerging from hibernation, but when the plants are left until December 21 the average weevil has but 94 days to remain without food before leaving winter quarters. The average length of life of the weevils after leaving hibernation was 10.7 days, the longest lived individual living 144 days. The life of the weevils becomes shorter after leaving hibernation as the weather becomes hotter.

The weather conditions during the winter in which these investigations were made are considered in detail and the authors conclude that "We might therefore be justified in supposing that the normal winter would be survived by a slightly smaller percentage of the weevils, though an average difference of 3.1° in temperature could hardly be expected to materially increase the winter mortality among the insects," and "In the average season the weevils would emerge from hibernation somewhat more quickly during May than they did in this experiment. The winter was an exceptionally dry one tho not far from normal so far as the temperature was concerned." They conclude that the number of weevils living thru the winter of the experiment was above the average, but that the rate of emergence from hibernation was normal.

E. D. SANDERSON.

Lead Arsenate, by J. K. HAYWOOD and C. C. MCDONNELL, U. S. Dep't. Agric., Bur. of Chem., Bul. 131, p. 1–50, 1910.

This interesting bulletin is in three parts. The first is on the results of a chemical examination of the composition of lead arsenates found on the market. Analyses of fifty different samples produced by fourteen different firms are given. That the names of these firms are not given is to be regretted, though the reasons for this are obvious, for anyone planning to buy arsenate of lead would probably avoid purchasing of manufacturer J. of the list, for example, if he could learn for whom J. stands.

On the whole, the analyses show a considerable variation in the amount of arsenic present and too much of it is in a soluble form, in many cases

As a consequence, spraying with some brands might prove inefficient, simply because of the small amount of poison present, or might cause injury to the foliage because of an excessive amount of soluble arsenic. It is noticeable that there is a great difference in the amounts of arsenic and lead present in the different samples analyzed. This should make a great difference in the preparation of the material for application to the trees. In one case noted, the material which is evidently in the form of a dry powder, contains more than twice as much arsenic as in another sample which is in the form of a paste and contains over sixty per cent. of water. To prepare such widely differing samples by the same formula for spraying would be liable to lead to most divergent results.

The second section of the bulletin treats of "home-made" lead arsenate and the chemicals entering into its manufacture. Analyses of samples of lead acetate, lead nitrate and sodium arsenate gave, for the most part, quite satisfactory results, the latter showing the greatest variations in composition. Attention is called to the point that when sodium arsenate having an unusually high per cent of arsenic is used, it is possible that ordinary formulas would fail to provide lead enough to combine with all of this, thus leaving a soluble salt of arsenic in excess in the spray to endanger the foliage.

Comparison of numerous published formulas shows considerable variation in the amounts of the different substances to be taken, leading in some cases at least, to the addition of materials which will be in excess of the amounts needed. To avoid this, directions for preparing lead arsenate both with lead acetate and with lead nitrate are given, for the different usual grades of sodium arsenate. It is not probable, however, that the average sprayer will take the trouble to test the material to determine when the lead comes to be present in excess, much as this is to be desired.

Until the present time, the general preference seems to have been in favor of using lead acetate instead of lead nitrate as a material. Comparative experiments here given, seem to favor the latter as being slightly cheaper, slightly more poisonous and the lead arsenate produced by its use settling much more slowly than that made from the acetate. This would seem to differ from the results obtained by Colby, who found (if the recollection of the reviewer be correct) that the arsenate of lead made from lead nitrate settled much more quickly than that made from the acetate, and it would now seem desirable to repeat these tests. An added point not mentioned in this bulletin is that after standing a while, the acetate becomes delequescent, thus changing its value.

The third, and in some regards the most interesting section of the bulletin is devoted to the action of lead arsenate on foliage, the results of investigations in which Mr. A. L. Quaintaince of the Bureau of Entomology, cooperated with the authors. Starting from quoted statements of the safety of the material at almost any strength, the fact that injury results in some cases despite these views, led to inquiries as to the cause, atmospheric conditions as the explanation seeming to be the most probable. These were studied for six months in 1907 and 1908 in connection with the spraying. The conclusions reached are, of course, tentative, but so far as they go, indicate that more or less decomposition of the lead arsenate was caused by the presence of various salts in the water, particularly sodium chlorid and perhaps sodium carbonate. Weather conditions also appeared to have some effect, injury results to the foliage (and fruit) following an application

followed by clear hot days and no rain, while spraying followed by cool days and rains resulted in no injury. The suggested explanation is that in the former case the dews at night would be sufficient to moisten the material and the hot sun the next day would produce conditions needed to dissolve the greatest amounts of arsenic, while if rain were to follow, the sodium chloride and carbonate would be washed out, leaving nothing to cause the breaking up of the lead arsenate.

The bulletin is a valuable one and very suggestive for those accustomed to looking at such subjects from their chemical aspects. It is somewhat questionable, however, if the average fruit grower might not desire a more direct series of statements as to the conclusions reached, which would guide him better in his subsequent spraying. H. T. F.

Ants, their structure, development and behavior, by WILLIAM MORTON WHEELER, Ph.D., Professor of Economic Entomology, Harvard University; Honorary Curator of Social Insects, American Museum of Natural History. New York, Columbia University Press, 1910, p. I to XXV; 1–663; 286 figures.

This is a comprehensive work written by an acknowledged master in the group and dealing with the structure and biology of these extremely interesting forms. The reader needs only to refer to the 70 closely printed pages of the bibliography to gain some idea of the vast amount of labor in digesting these almost innumerable and widely scattered records and co-ordinating them with observations extending over a decade.

The author considers that the social relations, attaining their "richest and boldest expression in the ants," arouses interest, owing to there being an undeniable resemblance to human conditions. The character of this volume is well indicated by chapters devoted to ants as dominant insects, the external and internal structure of ants, development, polymorphism, history of myrmecology and classification of ants, their distribution, fossil ants, habits in general, ant nests, driver and legionary ants, harvesting ants, relation of ants to vascular plants, fungus growing ants, honey ants, guests, ecto and entoparasites, slave makers, the instinctive and plastic behavior of ants.

Economic entomologists will be particularly interested in the chapter treating of the relation of ants to plantlice, scale insects, tree hoppers and caterpillars. The discussion, while comprehensive, is not unduly extended. Here, among other interesting notes, we find a very lucid account of the aphid cornicles and their functions. The extermination of noxious species is concisely discussed in an appendix. The value of this important work is greatly increased by a key to the subfamily, genera and subgenera of the North American Formicidæ, together with a list of the described species. The author is to be congratulated upon having produced an authentic, scholarly discussion of a highly interesting group.

Corn Weevils and Other Grain Insects, by R. I. SMITH, N. C. Agric. Exp't. Sta. Bul. 203, p. 1–27, 1908.

This popular bulletin discusses in a summarized manner the more important grain insects. The author wisely emphasizes the value of preventive

measures, advising early threshing and tight sacking of small grains. Burning sulfur, 2½ pounds to 1,000 cubic feet, is especially advised in cleaning granaries, though it can hardly be recommended for those containing grain, since this fumigation will prevent germination. The standard fumigant, carbon bisulfid, the author finds, must be used much stronger than usually recommended.

Shade Trees, by E. A. START, G. E. STONE and H. T. FERNALD, Mass. Agric. Exp't. Sta. Bul. 125, p. 1–64, 1908.

This excellent general bulletin gives much practical information to the tree lover. The entomologist will be interested in the discussion of the care and protection of trees, especially that part relating to tree surgery and the effects of gas and electricity on trees. Summary accounts are given of a number of the more important insect enemies of shade trees.

A Chemical Study of the Lime-Sulfur Wash, by L. L. VANSLYKE, C. C. HEDGES and A. W. BOSWORTH, N. Y. Agric. Exp't Sta. Bull. 319: 383–418, 1909.

The general bulletin on the chemistry of the lime-sulfur wash is something entomologists have been desiring for several years. Dr. VanSlyke and his associates present in this publication, data of great value to those recommending this valuable insecticide and fungicide, since he gives in concise form the different effects from prolonged boiling and those obtained by employing different proportions of the essential constituents. The data relating to the effect of Magnesium shows the deleterious effects following its employment. This bulletin gives a series of facts which may well be employed in determining the value of the various brands of commercial lime-sulfur washes.

Concentrated Lime-Sulfur Mixtures, by P. J. PARROTT, N. Y. Agric. Exp't Sta. Bull. 320: 419–38, 1909.

This is a discussion of the concentrated lime-sulfur mixtures, from the entomologist's standpoint, being based upon the results given in the preceding bulletin and largely supplemental thereto. The author finds little of insecticide value in the sediment of certain concentrated washes and advises the use of the Beaumé scale for testing the strength of the preparation. The table of dilutions will prove most helpful to fruit growers.

A Handbook of the Destructive Insects of Victoria, by C. FRENCH, Prt. 4, p. 1–195, with 33 colored plates; Osboldstone & Co., Melbourne, 1909.

The fourth part of this interesting and well known series contains notices of a number of injurious species, and departs somewhat from the preceding volumes in discussing some of the forest tree pests. Our nursery inspectors will be particularly interested in the regulations governing the shipment and sale of fruit and vegetables, given at the beginning of the volume, while the somewhat extended accounts of the two fruit flies noticed, will appeal to entomologists having to deal with their allies in this country. The notices of

the various species are invariably illustrated by rather well executed colored plates showing the various stages of the insects and their work, and in some instances illustrating parasites. It is interesting to note that the horse bot fly, *Gastrophilus equi* Fabr. is becoming abundant in that section of the world. The concluding pages are occupied by a series of brief accounts, likewise illustrated with colored plates, of a number of Victorian birds, the author emphasizing their economic value, particularly as destroyers of insect life. The final pages are devoted to a brief discussion of insecticides. The lime-sulfur wash and miscible oils appear to be unknown in Victoria.

Insect Depredations in North American Forests, and Practical Methods of Prevention and Control, by A. D. HOPKINS, U. S. Dep't Agric., Bur. Ent. Bull. 58; Prt. 5, p. 57–101, 1909.

This is a summarized discussion of insect injury to forests, with brief notices of some of the more destructive species affecting the important trees or their products. There is also an interesting dissertation on the interrelations existing between insects and forest fires. The author estimates the total loss on forest products in the United States at $100,000,000. Some pages are devoted to the principles to be observed in controlling forest pests, with several accounts of instances where they have been successfully applied. The author advocates the utilization of the natural enemies so far as possible. He rightfully emphasizes the importance of more systematic biologic work to give a scientific basis which may be used in devising practical methods of control, insisting that the former is a necessary preliminary. This bulletin gives in small compass, a large amount of very suggestive information. The appended list of publications relating to forest insects, will prove of material service to students of the subject.

The Pear Thrips and Its Control, by DUDLEY MOULTON, U. S. Dep't Agric., Bur. Ent. Bull. 80, Prt. 4, p. 51–66, 1909.

This most excellent, detailed account with a number of original illustrations, gives an extended discussion of a new fruit pest, *Euthrips pyri* Dan. This insect is believed to have originated either in Europe or China. The remedial measures advised are plowing and timely spraying with a contact insecticide. The tabulations and text are both admirable and the publication might well be adopted as a model in many respects.

The Raspberry Byturus, by W. H. GOODWIN, Ohio Agric. Exp't Sta. Bull. 202: 174–86, 1909.

The commendable, detailed account with a number of original illustrations, and especially strong on the biology, is based on careful field investigation as well as a study of the literature. Heavy applications of arsenate of lead are advised. A bibliography is appended.

Current Notes

Conducted by the Associate Editor

Dr. Raymond C. Osborne has been made Assistant Professor of Zoölogy in Barnard College.

Mr. Charles R. Jones, formerly of the Bureau of Entomology, and located at Dallas, Texas, has accepted the position of Entomologist of the Philippine Islands, with headquarters at Manila, P. I.

Mr. Alfred B. Champlain, formerly assistant in the Division of Economic Zoölogy at Harrisburg, Pa., began his work April 1st in his new position as assistant in entomology at the Agricultural Experiment Station, New Haven, Conn.

Mr. Merrill A. Yothers has recently been appointed assistant entomologist at the Agricultural Experiment Station at Pullman, Washington. Mr. Yothers formerly held a similar position at the Michigan station.

Rev. J. S. Zabriskie, well known as an entomologist and microscopist, and a member of the Brooklyn Entomological Club, died at his home in Brooklyn April 2d, at the age of seventy-five years.

At the Bussey Institution of Harvard University, Forest Hills, Mass., a course of illustrated lectures in economic entomology and genetics has been arranged for Sunday afternoons at four o'clock, beginning April 19th and closing May 29th. The entomological lectures are as follows:

April 10th, "Insects as Carriers of Disease. I. The House Fly and its Allies," by Professor W. M. Wheeler.

April 17th, "Insects as Carriers of Disease. II. Mosquitoes and their Allies," by Professor W. M. Wheeler.

May 8th, "The Gypsy and Brown-tail Moths," by Mr. C. T. Brues.

May 15th, "Insects Injurious to Elm Trees," by Mr. C. T. Brues.

The staff of the Texas Experiment Station, located at College Station, Tex., has recently occupied the new Administration Building, lately erected at a cost of about $47,000. The building is of modern fire-proof construction, of two stories and equipped with all modern devices. The upper floor is occupied by the chemical department, where special apparatus is installed to prevent the spread of fire. All floors in the laboratory are of concrete and all rooms are connected by fire-proof doors. On the lower floor are the offices of the Director, Agriculturist, Feed Control Bureau, Plant Pathologist and Entomologist. The Entomologist of the Station, who is also State Entomologist occupies a commodious office and laboratory. The basement of the building contains storerooms for all Departments. The installation of the records of the research work conducted in the Station, in a building thoroughly protected from fire, is a step well worth emulation by other institutions of a similar kind.

Mr. Harper Dean, formerly connected with the Bureau of Entomology, Cereal Crop Insect Investigations, resigned on March 1st to accept the position of Agricultural Editor of the *Semi-Weekly Express* published at

San Antonio. In his new field Mr. Dean has opportunity for serving a large part of the agricultural population of Texas. Mr. Dean's new work is already making a creditable showing. Considerable space in the *Semi-Weekly* is regularly devoted to timely articles on Economic Entomology.

The Minnesota State Entomologist, by means of an appropriation given him by the last Legislature, has had prepared and distributed to all the schools of Minnesota, colored charts showing some of the more common injurious insects of the state, some beneficial insects, and some useful birds. The chart is 36 inches by 46 inches, made to hang on the wall of the school room. Under each colored figure is descriptive text, giving briefly the economic relation of the insect or the bird in question to the farmer or orchardist. Over seven thousand of these charts have already been distributed to Minnesota schools.

The Entomological Division of the Minnesota Experiment Station is now publishing a monthly leaflet, or journal, containing timely items of interest, advice and suggestions to farmers, housekeepers and gardeners, mailed free to any citizens of Minnesota who request it. This is not a bulletin, but more like a circular. Its aim is to get timely advice and news of insect conditions to the Minnesota agriculturists during the growing season, and is to be published and issued the first day of May, June, July, August and Semptember.

The increased interest in Entomology is shown by the following statistics from Prof. H. F. Wickham of the University of Iowa. Last year he had an increase in his classes of about 50 per cent over the best previous record and this year shows a further advance of 40 per cent over last. He now has close to 100 students taking work in entomology, though the courses are entirely elective.

CORRECTION FOR LEGEND ON PAGE 115

Fig. 6. Germination of seeds at different temperatures by De'candolle, as given by Abbe, original. .———. *Lepidum sativum;* ———x *Sinapsis alba;* ——— — — ——— *Zea mays;* — — — — *Linum usitatissimum;* ——— — ——— *Trifolium repens;* . . . . . Melon, cantaloupe.

Mailed, June 15, 1910.